The Builder.

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What is meant by "Durable" Stone?

CONSIDERABLE difference of opinion exists as to what may, or may not, be called durable stone. One individual may be clear that a certain stone is a good one to withstand the action of the weather, whilst another is equally convinced to the contrary, and to a certain extent they may both be right in their judgment.

The manner in which a stone behaves after it is built up so very much depends on surrounding circumstances that the nature of the locality of the building must always be an important factor in considering the durability of a freestone. Yet how often is this thought of? To a certain extent it is recognised that there are freestones which do very well for the country, but which will not withstand the London air, and few people get beyond this; whilst only a very small section seems to appreciate why even such a difference as this should be made. For example, the majority say that, in order to judge whether a certain stone would be durable in London, or any other large city, it is necessary to go to the place where the material is quarried and examine the buildings in the vicinity, especially ancient ones, and, if there are many signs of decay in the stone, it may be taken for granted that it will not do for London. Now this by no means follows. In the first place, it is nearly always extremely doubtful what is the particular kind of stone an ancient building is made of. The edifice may be in close proximity to a quarry, and yet may not be constructed of the stone from it. Many stone-merchants' circulars and statements are very misleading in this respect. The material used for the ancient building may, superficially, appear to be exactly the same in tint, grain, and every other characteristic as that in the quarry hard by, yet it may have come from another source; it may not be far off, but quite far enough to make a considerable difference in the structure of the stone. In a distance of a few hundred yards, the tint or grain of a stone may not be altered; but it may, nevertheless, have undergone a considerable change, by the absence or presence of a filtrating or cementing material, which is the fundamental part, constituting the very essence of its durability. And, in many instances, nobody could prove this alteration without making the most minute examination. Unless the individual conducting the inquiry is armed with proper scientific apparatus, it is astonishing how easily he may be deceived on a point of this nature. It is necessary to be very careful, therefore, in admitting the enduring qualities of a stone from mere superficial examination.

Certain other elements creep in, tending to make the comparison of the ancient stone with that in the quarry still more doubtful. For the purposes of argument we will assume that the ancient building really was made of the stone from the contiguous quarry. Leaving on one side the possibility of the quarry having been expressly opened for supplying the material for the building in question, when bad surface stone would probably be more or less used, we are nearly sure to find that the freestone was taken from all levels, indiscriminately, in the quarry. As a rule, four or five beds of stone occur in a quarry, frequently having a certain resemblance to each other, but which are none the less of different qualities, as is usually shown by the stone-merchants' price-lists. If, then, the ancient structure be built of stone from various beds, how can we expect it to furnish us with much information as to the durability of the material, which the proprietor now only sells from the more marketable levels, whether they be good or bad? It is obvious that an entirely erroneous impression may be created in regard to durability unless we recognise these facts. A case has recently come under our observation which abundantly illustrates this point.

Within the precincts of a certain village, stone-quarries were re-opened which, for many centuries, had supplied material for all the important buildings in a neighbouring town, and for many miles around. Some of the edifices, which are at least 700 years old, show that the stone of which they are built has resisted the ravages of time in a most marked manner. A general report on building stones alludes to this fact, and laments that this very enduring material is not more extensively used. Now, this is all very well so far as it goes; but, unfortunately, on investigation, we find that the stone used in the buildings referred to can no longer be obtained,—or, rather, it can be obtained, but at prohibitive prices. The facts are as follow:—There are at least four different kinds of stone in the quarries in question. Of these, one is an altogether worthless material, so far as its power of endurance is concerned; two others are fairly durable freestones; whilst the fourth kind is very durable, though hard. The ancient buildings in good preservation are largely made of the last-mentioned variety; but it costs so much to work and shape that it is now practically unmarketable, and the ordinary produce of the quarries is almost entirely restricted to those of a fairly durable description. At the same time, the stone merchants take credit for the better class of material; and it would not be difficult to cite other cases of a similar nature.

Another element worth considering is as to how far railways and increased facilities of carriage have affected the selection and use of building-stones. Several important durable freestones, largely used in the Middle Ages, have more or less dropped out of the market, apparently because their distance from railway or convenient water carriage has enabled competitors more favourably situated to place a somewhat similar material in the market at a much cheaper rate. And it is instructive to note that in several districts where the "iron horse" has been but recently introduced, some of these old quarries have been re-opened, and the stone industry revived.

When we hear of the great care with which many of the earlier architects selected their stone, we are tempted to inquire whether their clients' unlimited purses, or the absence of the demon competition, had not something to do in bringing about such a favourable result. In this connexion, however, it is well to bear in mind that unless durable material had been originally used, the chances are that we should have nothing left of the buildings to enable us to form an idea on the subject at all.

Comparatively modern cottages in the vicinity of a quarry, even when they are known to be made of the produce of the working, do not often afford a very sure index of the durability of the stone in the quarry, albeit we know that they are frequently believed to be good examples to study in this respect. As a matter of fact, such cottages are often made of quarry "refuse," which, in the majority of cases,—especially in a sandstone district,—comprises hard blocks of stone which could not be easily tooled, and hence have been thrown aside. It frequently happens that the greater portion of this "refuse," therefore, is exceedingly durable,—much more so than the ordinary produce of the workings. This "refuse" is also very largely used for walling, &c.

Our remarks hitherto are made to apply irrespective of locality. As we said at the outset, the *locale* of a building remarkably influences the durability of the stone of which it is built, and we have reason to suspect that differences of opinion in regard to the weather-resisting qualities of certain well-known stones in a great measure arise from the non-consideration of this circumstance. For instance, we are all aware that the amount of rain which annually falls in England varies very much according to the district, and that in the western counties many places receive three or four times—and in some parts of the Lake district six times—as much rain as eastern and south-eastern England. This means that in the more rainy districts, much greater proportions of the acids which combine to rot ordinary freestone are introduced into the walls through the agency of rain and moisture generally than are introduced into them in the drier areas; and, *cæteris paribus*, the rate of disintegration of the stone will consequently be very much more rapid in the former than in the latter districts. Here, then, we have a most powerful factor, influencing the comparative durability of stone, which is hardly ever taken into account; and it is a fact that a stone which may be durable enough for a moderately dry district will be quite unfit for a more rainy area, where the agents of destruction are present in much greater force.

Furthermore, the distribution of rain is extremely capricious, depending as it does so much on local circumstances. The precipitation is effected to a great extent by the trend of the valleys, so that the difference is not the same in proportion in adjacent valleys, or, indeed, on the different slopes of the same hill. Trees are great attractors of rain, more particularly on elevated ground, and a mansion-house built near a forest or large clump of trees, under certain conditions, receives a much greater quantity of moisture than one not so situated, even though they may not be far from each other. As hills and mountains also, by chilling the air in contact with them, cause the condensation of moisture in the atmosphere, so there is generally a greater rainfall in their neighbonrhood than in the less elevated portions of the country around, and buildings erected near such high ground will suffer accordingly. Questions may fairly arise respecting the comparative durability of stone to be used for building in such cases.

The position of an edifice, as to how far it is sheltered from the prevailing winds, and with reference to the direct action of sunlight upon it in drying-out moisture from the stone, should always be considered in a critical enquiry. And this leads us to perceive that the design of the building itself may also materially influence the rate of disintegration of the stone of which it is built.

The distribution of temperature must likewise be taken into account, and especial note made of places where the temperature very frequently falls below the freezing-point, or which are subjected to great diurnal changes in temperature. It is not easy to get much precise information on these points. Isothermal charts give the monthly or annual range of temperature in a district, and we are enabled to find that it is much warmer, as a rule, in the western and south-western than in the eastern and south-eastern portions of England. But these charts are necessarily drawn up from averages. We are not so much concerned with average temperatures. What we want to know are the maximum and minimum daily temperatures throughout the year for any given spot, and this is not obtainable except at certain fixed stations. According to isothermal charts, a district may have a tolerably low annual or monthly average temperature, which fact might lead us, at first sight, to suppose that the freezing-point was more often reached there than in another area having a somewhat higher average; but, although this may be true in a general sense, the converse not unfrequently is the case. The durability of stone is not materially affected by temperature, unless the latter often falls below the freezing-point, on the one hand, or unless great changes frequently occur in its diurnal range, and this will be felt the most where the change is most rapidly brought about, on the other hand. In the former case, the water retained in the pores of the stone is frozen, the formation of the ice causing an expansion which loosens particles of stone, which fall from the parent mass on thawing, unless their cohesion be strong enough to resist the expansion. In the latter instance, the rapid contraction on sudden cooling causes portions of the material to split off. This phenomenon is of such frequent occurrence in certain parts of the United States that its consideration is of primary importance in selecting stone in that country.

Turning now to the relative value of stones in regard to their durability in towns, it will be at once seen that not only have many of the foregoing facts to be considered, as to the position of the buildings, rainfall, temperature, &c., but the nature of the town itself must form a prominent feature in the inquiry. If it be a quiet old cathedral city, with a non-manufacturing population, its building-stone will last very much longer than in another city of the same size having many manufactories, and especially if these latter be pottery or chemical works. The amount of carbonic, sulphuric, and hydrochloric acids (communicated by these industries to the atmosphere) is far greater in the latter than in the former kind of town, and the rate of disintegration of building-stones in it will be correspondingly increased.

If the city be very large (as London, for example), it will be found that the stone in certain parts of it lasts much longer than in others,—a circumstance largely due to the absence or presence, as the case may be, of certain kinds of manufactories in the immediate vicinity.

The due consideration of all these facts will go a long way to explain why one man finds that a certain stone is durable, while another has the contrary experience. The former may be accustomed to using the material in localities comparatively favourable to its preservation, whilst the work of the latter may oftener lie in more unfavourable districts.

Some differences of opinion also unquestionably arise owing to the word "durability" having a very elastic meaning, which may be expanded or contracted at the will of the individual. But this does not do away with the fact that the same kind of stone often behaves very dissimilarly under different conditions, which conditions do not seem to be sufficiently taken into consideration when opinions are formed respecting its durability. This is especially the case in regard to the building-stones used in the provinces.

In the preceding remarks we do not, of course, allude to buildings made of different qualities of each kind of stone, but have assumed that the stones compared under separate local conditions are in each case from the same quarry and stratum; and in doing this we are quite within the mark, for it is not difficult to institute comparisons of the kind.

From a study of the subject, we have come to the conclusion that although many people recognise the advisability of carefully selecting stone for London use, they do not fully appreciate the advantage of exercising the same amount of care in choosing the material for provincial residences, where the surroundings may prove quite as unfavourable to its preservation.

The New Finnish House of Parliament.—The commission appointed for considering the designs for a new House of Parliament at Helsingfors, to which we have previously referred, has decided upon accepting that of the Swedish architect, Herr Nyström, of Stockholm.

A PROBLEM IN THE BRIDGING OF NAVIGATION WAYS.

THE Clyde in its conditions below Glasgow Bridge bears a general resemblance to the Thames below London Bridge, with, however, one or two points of notable difference. It is a tidal harbour, filled with shipping for about two miles downwards; but, unlike the Thames, is lined on either side with uniform quay walls, which the water never leaves, even at the lowest of neap tides. The bulk of the loading and unloading of ships is performed at these quays direct, and there is no lighterage traffic,—at least, none in the Thames sense. Here and there, carved out of the river margin, there are accessory docks or harbours, all of comparatively recent formation; but these, as compared with the river itself, are not at all in the preponderating proportion, and the ruling feature of the port is the clean-cut channel of the Clyde itself, furnished throughout with unbroken quayage lines. The left bank, for a considerable distance off to the south, is level, and of small elevation above high-water mark; the right bank is flat also, although by-and-by diversifying into a rise on a moderate gradient. During the last three or four decades the city has extended enormously over both these areas. On either side engineering works and general factories abound, and the affinity, in habit and pursuit, between the two is much more marked than in the London case. The daily and hourly interchange of traffic is naturally large of bulk, vehicles going round eastward by Glasgow Bridge or westward by the horse-ferry at Govan, while passengers are served by small but nimble steam ferry-boats, plying at about half-a-dozen intermediate stations. This combination of service has long been pronounced eminently unsatisfactory by the riparian factory owners, an influential body of men, and for some years the cry for additional cross-river communication has been of frequent recurrence. These, if permitted, would simply bridge the port on the quay level, at one or two points between Glasgow Bridge and Govan Ferry, and accommodate the incoming and outgoing harbour traffic,—or make a feint of accommodating it,—by the expedient of a lifting span in the centre of the structure. But, however desirable in itself improved cross-river communication between the two sections of below-bridge Glasgow may be, it would certainly be too dearly bought, to the community at large, by the practical spoliation of the harbour and magnificent sea access which have contributed so largely to make the city what it is. This, hitherto, has been the guiding conviction of those in whose care lies the conservation of the port and river, with the result that the low-level bridge plan, after several bold attempts, rests for the time virtually defeated. The Clyde Trust would, of course, resist any scheme of the sort to the death, and as the Clyde Trust is, in its personality, almost identical with the City Council, it will be seen that the only chance of these bridge-promoters lay in the furtive passing through of a measure at a time when public and official attention was elsewhere engrossed. This seems past hoping for, and they have now become reconciled, it would appear, to the next best admissible expedient. The impression that something must be done being pretty generally diffused among all sections of the citizens, it is now all but certain that within a few months some plan will have been decided on. Several debateable schemes have of late been under irregular discussion, the low-level swing-bridge alternative having for the time practically disappeared from the field. Plans for a high-level crossing have been advanced by Mr. Arrol, of the great Forth Bridge undertaking. This would rise sufficiently to clear masts of ships; traffic would ascend to it by an inclined way, beginning at the bridge-end on either side, and rising in a quick but practicable gradient, while proceeding laterally on a line with the quay, some hundreds of yards away

from the crossing; afterwards, by means of a sharp bend, returning and forming a junction with the roadway of the bridge, the necessary elevation having by this time been attained. For this design it is claimed that, considering the rather imperative conditions imposed, there is very little actual quay-space taken up, and the drawings bear this out so far; but, besides the unsightliness of the whole as a prominent river feature, it is very questionable whether any but the stoutest-hearted of traffic would prefer these killing inclines to the longer, but less-exacting, round, *viâ* Glasgow Bridge or Govan Ferry. A system of tunnelled roadway has been discussed, and to perhaps rather more of present purpose, steps having already been taken towards the introduction of a Bill at an early date. This scheme, which is privately, not officially, promoted, contemplates twin tunnels, of 15 ft. to 18 ft. diameter, for the wheel traffic (with an accompanying smaller bore for pedestrians), at a suitable depth below the water level. Shafts, with gearing on the hydraulic-lift principle, would lead to and from these for the accommodation of the carriage traffic, and stairs also for descent and ascent by foot-passengers. A scheme of this kind necessarily places a fixed limit on the depth of the port, and for this reason watchful opposition on the part of the Clyde Trust may be reckoned on. This is, perhaps, the chief objection; otherwise, some of its advantages are undeniable. It reduces interference with the existing port traffic to a minimum, and is in this respect distinctly preferable to bridge and ferry alternatives alike, no matter how carefully solicitous the designers of the latter may have been. Still, all high-level bridge and tunnel proposals bristle with inherent drawbacks, and these are deemed so formidable that many have turned to ferry transit, on the most improved system, as after all the least objectionable solution. Several plans have been put forward, and one of these found place in last year's Exhibition, although in a position so obscure as to be practically overlooked. By general consent, the desideratum is a ferry-boat which will receive wheel traffic from the level of the quay at all times of the tide, and allow the same to similarly walk away on the other side. It is claimed that this has been attained by a vessel fitted with a movable traffic deck, which will rise with the fall of the tide, and fall with the rise of it, so as always to present a level identical with that of the quay, and as already exemplified in several working examples. This seems to offer a solution which, on the whole, is less beset with objection than any other. The system would necessitate watchful eyes on the part of the up-and-down navigation, but already the numerous passenger-ferry crossings compel constant watchfulness; and, besides, whatever may be the expedient adopted, the interests of the navigation must give a little as well as take a great deal. If they are delivered from such a congestion of the port-passage as the threatened low-level swing-bridge contrivance would certainly bring about, the Clyde Conservancy authorities may well make up their minds to a toleration of the occasional impediments due to the cart-ferry crossing system, even although that institution be set up in the busiest portion of the harbour.

NOTES.

THE London County Council cannot be said to have begun its career in a manner that promises very well for the future. After all that has been said about the importance of its being a non-political body, and the absolute unsuitability of importing politics into the proceedings of a Council which is elected for the purpose of carrying out important practical work, the opening meetings have revealed the dragon of political party spirit in an obviously rampant attitude. Even the women's rights question seems likely to be dragged in by the presence of two ladies who probably have not the slightest acquaintance with the subjects which ought to form the main business of the Council; and Mr. Firth's silly attempt to set the fashion of addressing the Council as "Ladies and Gentlemen," instead of addressing the chair, was obviously the demonstration of a sympathising "progressist" to bring the presence of the lady members prominently in evidence. Miss Cons, who has been elected an Alderman (or Alderwoman), is a lady of very businesslike ability, which has been evidenced in her management of more than one large philanthropic scheme, and if ladies are to be admitted, none could have a better claim; but the passing over in the election of Aldermen of such a man as Sir Douglas Galton, who has so much of the precise kind of knowledge, experience, and ability that a County Council is likely to stand in need of, is a piece of sheer stupidity, the more noticeable in comparison with some of the very inferior candidates who have been pushed in for mere political reasons.

TWO cases under the Employers' Liability Act, both rather curious in their circumstances, were decided on Tuesday. Both were hearings on appeal, before Mr. Justice Denman and Mr. Justice Hawkins; that of Perry *v.* Brass & Son from the Southwark County Court, where the jury had been unable to agree; that of Hooper *v.* Studds & Son being an appeal by the defendants. In the first case, the plaintiff, a painter, was working under the defendants' foreman Scrivener, at the General Post Office, and, asking for a ladder, was referred to a foreman in the employ of the Office of Works, who produced one, which broke while plaintiff was on it, and caused him a fall and injuries. The facts that the ladder was unsafe and that the plaintiff was injured through its giving way were not disputed, but unfortunately for him (in one sense) the ladder was not the property of his employers, and it is pretty clear that the plaintiff, being unable under the Act to proceed against the real owners of the ladder, who were not his employers, proceeded against the latter in the hope of getting damages illegally from a sympathetic court. We may be sorry for the plaintiff's accident, but his procedure against Messrs. Brass & Son was perfectly unjustifiable, and judgment was, of course, given for the defendants. The moral of the case is that workmen wishing to be protected under the Act should use their employers' plant, and not that belonging to other persons. In the second case referred to, Hooper *v.* Studds & Son, the plaintiff was working on a scaffold on the exterior of a building which was being taken down, when the ceiling inside fell in, and the plaintiff, alarmed by the noise of something falling, ran inside for shelter, when fragments fell on him and injured him. In the first trial the plaintiff obtained 80*l.* damages, against which defendants appealed, on the ground that the giving way of the ceiling was not a defect in their plant. The judges on appeal, however, thought that there was evidence of defect in shoring:—

"The Court suggested that it was a case in which it would be desirable, if possible, to come to some settlement, so as to spare the parties the expense of further litigation. If the Court should think the evidence unsatisfactory, then there must be a new trial. And here the injury arose to the man indirectly through his having gone inside the building; and then a difficult question arose, whether the building itself was part of the ways, works, or plant, so as to come within the Employers' Liability Act, and on that there would probably be an appeal allowed. In mercy to the parties a settlement was suggested."

Plaintiff's counsel left the matter in the hands of the Court, and the Judges thought the damages should be reduced to 20*l.*, and each party pay their own costs. No doubt the plaintiff running inside the building indirectly brought the injury on himself, but this can hardly be called "contributory negligence," being rather an intuitive movement of self-preservation under a sudden sense of danger. The point of interest in the case is as to whether an accident of that description really comes under the legal definition of "defective plant," a point on which the learned judges seem to have been undecided, though their opinion evidently leaned to the affirmative. Morally, no doubt, the defendants were responsible.

SOME very interesting discoveries have just been made at the Church of St. Olave, Old Jewry. Owing to the parish having been united some years back to that of St. Margaret, Lothbury, it was decided that the Church of St. Olave should be pulled down, and its endowments utilised in the erection of an ecclesiastical edifice in some suburban district, the monuments and certain other interesting features being removed to St. Margaret's. The Church of St. Olave Jewry is a rather plain, but excellently-proportioned, building, and its interior is certainly not one of the least pleasing of Wren's works, though, for some reason or other, its effect was rather injured by the western organ-loft being brought so far forward into the nave as to rob it of more than one-third of its proper length; and although the loft was a handsome piece of work, the interior looks really finer without it. Before pulling the walls of the church down, it became necessary to make several rather deep excavations under the pavement at the west end of the building, in order to remove the vast aggregation of human remains which had accumulated, the result of the practice of intramural burials which had been here carried on for many centuries, and it was this work which has brought to light the discoveries to which we have alluded. It is evident that Wren built his church, to a great extent, upon the footings of the earlier one, which was destroyed by the Great Fire in 1666. This is especially to be seen at the west end, which appears to have been erected upon a portion of the old walls. The tower of the old church stood at its south-west angle, at the end of the south aisle, and its western wall was on the site of a portion of the west end of the present church. The bases of two old responds have been found *in situ*. One, which is fourteenth-century work, formed a part of the eastern tower arch; and the other, which is Perpendicular in style, was the western respond of the arch which opened into the nave from the north side of the tower. Below the tower is a plain vault, or crypt, which appears to be of the same date as the tower itself (*i.e.*, the fourteenth century). Some 7 ft. or 8 ft. below the pavement, at the west end of the nave, a very large, roughly-built Gothic arch has been brought to light; it is about 18 ft. in span, and is very acutely pointed; the voussoirs are uncut, and nearly 3 ft. deep. The form of the arch is very similar to those of Old London Bridge, and it is evident that it must have spanned a stream or sewer, because at right-angles to it, under the north wall of the nave of the existing church, is a brick arch, probably not earlier than Wren's time, but constructed of early red bricks (very long and narrow in form). Now, it is evident that this stream or sewer must have passed obliquely under the church, or have made a bend at this point, and it was probably one of the streams which, like the "Wall Brook," took its rise in the morass about Finsbury and Moorfields, and flowed through the City into the Thames. The Gothic arch cannot date *later* than the fourteenth century, and may be as early as the close of the twelfth; the rough hammer-dressed voussoirs and thick mortar-joints seem to indicate the earlier date. A cinerary urn of fine black clay was thrown up by the workmen near this spot, but, alas! broken in pieces. It appears to have been of a very elegant form, and is certainly Roman in date.

WE may, perhaps, be allowed to hope that the "Chalkotheke" of the Athenian Acropolis has at last found rest. The unfortunate building has been driven, by the gad-fly of archæological theory, round the whole circuit of the Acropolis. Originally supposed to have stood at the south-east corner of the Acropolis, when the present

excavations began its site was moved to the north-west, close to the Propylæa. The foundations found there (see the plan published in the *Builder* for February 25, 1888) are now held to be too small to have belonged to a building which was to hold the great number of bronze objects mentioned in the existing Chalkotheke catalogues. Also the bronzes found on that spot, which led to this identification, lay *beneath* the building, and must, therefore, have been older. The "Chalkotheke" is now to be identified with some foundations found recently in digging through the space intervening between the Parthenon and the precinct of Artemis Brauronia. The foundations are of a stoa-shaped edifice, 41 mètres long by 15 broad, faced by a row of columns, the foundation for which still remains. So far as we are informed, there is nothing to *prove* whether the building be the Chalkotheke or not, but the fact that some of the "Chalkotheke" inscriptions were found on this very (so-called) Ergane terrace is in favour of the identification,—an identification which has the support of Dr. Dörpfeld. A far more interesting matter, however, than any Chalkotheke identification is the fact on this "Ergane" terrace a large, substantial building has certainly once stood; a building, too, from its plan necessarily of some secular import. It cannot be itself a temple of Athene Ergane, and as it occupies the ground there can have been no such temple at all. Dr. Dörpfeld always prophesied that when the supposed precinct of Athene Ergane was excavated no temple would be found. The result has more than justified his views. Not only is no temple found, but no temple could have stood there. This is, of course, a fact of the utmost importance with reference to the much-contested lacuna in Pausanias (I. 24, 3). The discovery does not, indeed, prove that Pausanias saw the "old Athene temple," but it at least proves beyond dispute that he did *not* see the temple of Athene Ergane.

FROM a report by Dr. Airy to the Local Government Board (just issued, but dated December 12, 1888) on the prevalence of diphtheria in the northern outskirts of Norwich, it appears that the sewerage system of that town is in a by no means satisfactory state. The disease has been most manifested around the high-lying portion of the existing sewer system, especially in and about Philadelphia-lane, a long street of houses inhabited principally by the artisan class.

"In 1884 this street was provided with a sewer, which forms the highest branch of the northern low-level division of the Norwich sewerage system. The highest point of the sewer at the top of Philadelphia-lane is about 80 ft. above the river. The northern low-level main sewer takes the drainage of the whole of that part of the city which lies on the left bank of the Wensum (the Coslany and part of East Wymer sub-districts); it has very little fall; it is carried under the river at Foundry-bridge (the bridge by which Norwich is entered from the Thorpe railway station) to join the southern low-level main sewer, which, after receiving all the sewage of the main part of the city lying on the right bank of the river Wensum, passes on at a great depth, admitting large quantities of spring water from the chalk in which it lies, to the pumping station at Trowse, where it delivers into a sump 20 ft. below the river level. The influx of spring water into the deep outfall sewer (owing to defective construction) is so great (more than equal to the bulk of the sewage proper) that the pumps cannot master it, and the sewage in the sump generally stands only about a foot below the level of the river. This means that the whole of the low-level main sewer, and any of its branches that lie deeper than 1 ft. below the river level, are necessarily choked up to the crown with sewage that is nearly stagnant. It follows that the air in the higher branch sewers and drains connected with this water-logged low-level main is dangerously charged with the effluvia of the stagnant sewage, and is itself nearly stagnant, there being no air-thoroughfare in the main sewer to aid the circulation. Moreover, the construction of the branch sewers themselves is such as to increase the foulness of the sewer air, for they are furnished at intervals with catch-pits (or "silt-pits") at the manholes, which retain solid sewage matter with the silt, and thus become so many stinking cesspools, defeating the primary object of a sewer, which is intended to remove at once any refuse matter, liquid or solid, that is committed to it. I saw one of these silt-pits being emptied, at the bottom of Philadelphia-lane. Two loads of black stinking matter were removed from it."

Some quotations appended from the City Engineer's report of 1887 imply that there are a number of old brick sewers which ought to be replaced by proper stone-ware drains. "These," says the Engineer's report, "are built of soft bricks, roughly jointed in common mortar. The bottoms (this is of great importance) seem to have been laid without mortar altogether, or else it has all been washed out since. The joints are consequently open." From one or two sentences in the report, we gather that the whole of the sewage is pumped on to sewage-farms at Trowse; there is no mention of any of it being discharged into the river; but it is certain that the Wensum, as we had occasion to notice in passing through Norwich in September last, smells very offensively at the portion just above the aforesaid "Foundry bridge." A little way below the bridge the pollution seems to be diluted away, as the writer sculled down stream from one of the boat-houses without noticing any smell from the water; but above the bridge the smell from the river was strong and offensive enough to render even a stroll along the bank disagreeable. Does any sewage go into the river at this point?

THE *Century Magazine* for February contains an article of some interest on "Slow-burning Construction," an expression which the writer, Mr. Edward Atkinson, substitutes for the common, but practically incorrect, expression, "fire-proof construction." The subject is treated from the standpoint of American conditions of building, and more particularly in regard to mill and factory buildings, which we gather have been fertile sources of fires in the States. After referring to the exceptionally high rates of insurance prevalent in America, the author asks, "How can this waste be avoided?" adding that "it is useless to suggest the construction of buildings modelled on those of Europe, especially of those on the Continent; we have not a general supply of the soft and easily-worked stones of which most of the buildings in Paris and in many other foreign cities are constructed;" and the cost of many other articles of building is heavily increased by taxation. Assuming that timber must enter largely into the construction of factories and other such buildings, the writer proceeds to point out, "from many years' experience in the construction of textile factories," how these may be made more fire-resisting. His main complaint against the average American factory building is in regard to its roof, the ordinary trussed and ceiled roof forming a mass of timber at the top of the building with a space between roof and ceiling which is not open to inspection. The roof approved by Mr. Atkinson is a practically flat roof, with a very slight fall each way only, formed of beams resting on the walls and on intermediate supports, if necessary, the beams projecting a foot or two beyond the walls to form eaves, and covered with a roof of 3-in. planking laid from beam to beam, and covered, over the planking, with any exterior material that may be preferred. The author mentions "gravel-roofing, tin, or cotton-duck" (we do not know this latter material, under that name, at least); it is proposed to have thin roof-boarding on the thick planks, and, if the roof is exposed to great humidity within, "one inch of mortar between the planking and roof boarding." As to this last suggestion, however, it may be asked "what about dry-rot?" or is that pest of the builder less rampant in America? Roof-boarding with a bed of mortar below, and an impervious covering above, would seem to the English mind rather in a favourable position for the development of dry-rot. This condition, however, is not essential to the system. The same system is to be carried out in the floors, which are to be made of thick planking on beams, the result being that everything is exposed: there are no concealed between-floor spaces, and no built-up eaves externally. Mr. Atkinson regards granite as being, in his experience, the worst of all constructional fire-resisting substances:—"In a recent fire in one of the factories insured under the supervision of the writer, a granite post, 12 in. by 12 in., was reduced to sand by the same fire that burned into a wooden post next to the granite less than one inch." This is quite in accordance with some English experiences as to the behaviour of various substances under fire. The article, though especially referring to American conditions of construction, is one which may be read with interest by English architects, and is illustrated not by mere pictures, but by scientifically drawn sections of construction, with practical notes appended. The fact of such an article, so illustrated, appearing in a popular magazine, is creditable to the good sense and breadth of interest with which the best American magazines seem to be conducted. We doubt if there is a single editor of an English magazine who would see the value of such an article. A practical man who were to offer it would probably be told it was "of no public interest."

THE Edinburgh Town Council have had before them a report of the Lord Provost's Committee relative to the amount at the disposal of the Council under the Reid bequest for the erection of a memorial to Bruce and Wallace. The Committee express an opinion that the amount of the bequest is inadequate to procure a worthy memorial of the heroes, and they, therefore, recommend that 2,000*l.* be voted from the "Monument Fund Account" towards the undertaking. The matter was re-committed. The Council had before them a requisition on behalf of some worthy people in Tunbridge Wells for leave to erect a monument, of Sicilian marble, in Greyfriars churchyard (the Campo Santo of Edinburgh), to mark the spot where "Greyfriars Bobby" is buried. There is already a memorial of "Bobby," in the form of a granite fountain and bronze figure, which was erected several years ago opposite the gate of the churchyard at the cost of the Baroness Burdett-Coutts. This monument elicited the remark from a visitor that the Edinburgh people were so anxious to have an excuse for erecting a monument that they sought for heroes amongst their dogs. The legend, which is by many considered apocryphal, is that "'Bobby' for fourteen years would have no home but on the grave of his beloved master, until death removed the faithful sentinel." After some remarks, the offer to erect the monument was declined, with thanks.

DR. PARSONS'S report to the Local Government Board * (dated January 7), on an outbreak of enteric fever in the Staffordshire division of the Stourbridge Rural Sanitary District ascribes the disease to contaminated wells. Dr. Parsons says "there are no sewers in the locality; slop-water is conveyed to the nearest ditch by open gutters, generally of rude construction, and often mere irregular trenches in the ground." The further conditions may be gathered from the following quotations:—

"The privies are of the kind usual in the district, with large and deep open middensteads, into which the roof commonly drips. They are often in a ruinous, dirty, and offensive condition. Pigs are kept in large numbers, and often near to houses; nuisances being apt to arise from accumulations of manure, and of "wash" kept till putrid in tubs and brick cisterns. Most of the houses are supplied from wells, which are of considerable depth in the higher situations, but very shallow in the lower ground. The wells are not so constructed as to exclude top-soil soakings, and they have often within a few yards' distance sources of contamination, such as rough sewage gutters, privies, and pig-styes. From some of them samples of water have been sent to the county analyst, and these have all been pronounced contaminated and unsafe for drinking. . . . .

The action taken on behalf of the Sanitary Autho-

* These Reports are to be obtained (through any bookseller) from the printers, Messrs. Eyre & Spottiswoode; from Messrs. Adam & Charles Black, Edinburgh; or Messrs. Hodges, Figgis, & Co., Dublin.

rity has been almost confined to the supply of disinfectants, and the cleansing and fumigation of the houses at the close of the illness. A few samples of water have been sent for analysis, and when they have been found bad the inhabitants have been warned, but the polluted wells have not been closed, nor, except in a few instances, has the tap-water been laid on. There is great reluctance in the district to incur the expense of taking the company's water, and on the ground of the poverty of the inhabitants the Rural Sanitary Authority hesitate to enforce its use."

DR. BALLARD'S report to the Local Government Board (Jan. 7) deals with the causes of a fatal case of post-vaccinal erysipelas at New Humberston (Billesdon Union). The fatality is ascribed partly to purely medical causes, but partly also to the unsanitary condition of the room in which the patient (a child five months old) was left. The following are some of the facts given in the report, to which a plan of the premises (No. 24, Clara-cottages) is appended:—

"The surface of the common yard of Nos. 22 and 24 is well paved between the scullories of the two houses, and the rest of the surface of the yard was clean and free from accumulations. But along the yard wall on both sides was a caged run, occupied by a number of fowls, the floor of which run was encrusted, as is usual in such places, with trodden filth. The roosting-place for the fowls adjoins the scullery. At the end of the yard, about 40 ft. from the scullery door, which is the back entrance to the house, is the privy and ashpit of Nos. 22 and 24. The privy is an ordinary bricked pit-privy, and the excrement in it was on a level with the brick floor of the privy. The ashpit is covered, but open all along its yard front. It is sunk below the ground level, and contained a small deposit (some inches) of liquid matters and decaying refuse. It had been emptied when quite full and very offensive a few weeks before my visit, and the residents at No. 22 complained to me of the offensiveness of the proceeding. It appears on inquiry that it is not the practice to empty these receptacles in New Humberston until they are thus full. . . . The Inspector of Nuisances, Mr. G. Harrison, informs me that, although a drainage scheme for the place is now in progress, the whole of what is known as New Humberston is undrained, except where temporary inefficient provision has been made by means of cesspools, &c. I saw one of such cesspools with a broken cover, and much complained of, in a neighbouring front yard. . . . Nothing can well be worse than the condition of the roadway in the Victoria-road, along the whole front of Clara-cottages, about the middle of which row of houses stands No. 24. It is deep in slush and filthy mud, impossible to be crossed by a foot-passenger, and thoroughly cut up by the traffic that takes place along it. The footway also is scarcely passable from unevenness, sloppiness, and dirt. The Inspector of Nuisances says that this street especially has been for years in a most unwholesome condition for lack of adequate proper drainage, on account of its cesspools, &c. . . . . That New Humberston generally and the Victoria-road and Clara-cottages particularly should have been in this unwholesome condition is assuredly the fault of the Rural Sanitary Authority of Billesdon. Had the place been duly attended to by the Authority, and had they taken care that it was reasonably wholesome, this fatal attack of erysipelas would in all probability never have happened."

THE manifest improvement effected upon the façade of Edinburgh University by the removal of the parapet wall and railing has led to a like operation at the Tron Church, which is also improved by the removal of the surrounding enclosure. Sir James Gowans has moved in the Town Council that negotiations be entered into for the removal of the railings around St. Giles's Cathedral. Enclosures of this nature are often detrimental to the effect of the building they are meant to protect, and are apt to become receptacles for waste paper, straw, &c. Their removal, therefore, is a gain,—both in a sanitary and æsthetic direction.

THE old school of water-colour painters, that is content with broad washes and quiet neutral tints, holds in abhorrence opaque pigments, and does not attempt bright colours, has few better living representatives than Mr. E. M. Wimperis, R.I., some of whose latest work is just now on view at Messrs. Dowdeswell's Galleries. Most of the pictures are broad sketches, on or about the Arun, between Arundel and Pulborough, and have a charming air of having been finished on the spot, and not worked up in the studio afterwards. The few more finished drawings are from scenery in the same open country, and chiefly represent broad sweeps of rolling down, with great vistas of open country beyond dying away into the blue distance. Mr. Wimperis excels in painting this kind of scenery, but some of the most successful efforts in the present collection are the scenes in the hayfield, No. 26, "Windy Weather," and 54, "Haymakers." No. 11, "On the Sussex Downs," is a successful specimen of the former kind of scene, and is a little more ambitious as to size and finish than the rest. No. 3, "A Lane at Pulborough," is a nicely-composed little picture, and so is No. 23, "Sheep in the Stubblefield." We like, too, particularly, No. 50, "The Ridge of Noble Down," and 70, "Gleams across the Marsh." Mr. Wimperis is evidently at his best when the weather is not so; his wind-swept reeds and hay-fields are full of graceful motion, and he is happiest when he can introduce his grey and purple cloud-shadows and broken lights.

THE *Dispatch*, an Edinburgh evening paper, has been taking an interest in the architecture of the new Free Public Library in that city. Our attention has been called to the fact that on the 18th of last month it published "A professional view" of the matter as a quotation from the *Builder*. The criticism in question is not from our columns, nor do we by any means agree with or endorse it.

ROMAN THERMÆ: THE BATHS OF CARACALLA.*

BY PROFESSOR AITCHISON, A.R.A.

THE three classes of public buildings that are most characteristic of the Romans are their basilicas, amphitheatres, and baths. I will take the baths first, because they present more difficult problems in planning; and from their being vaulted, their construction must necessarily have required more thought and contrivance than open buildings, or those merely roofed with timber. There is this, too, that makes these Roman thermæ peculiarly interesting to Englishmen; it was known that Palladio had measured all the existing ruins of them at Rome, and drawn out restored plans, elevations, and sections, and almost certainly written a descriptive text, but had never published them. Richard, Lord Burlington, the architect who originally designed the front part of the building in which we now are, searched for these in Italy, and though the text was gone, he found all the drawings, but the plan of Agrippa's baths in the palace at Masera in the Trevigiana; this palace Palladio had built for Daniel Barbaro, the Patriarch of Aquileia, who published Vitruvius with his own annotations and Palladio's illustrations in 1567. Lord Burlington published in London mezzotint engravings of these drawings of Palladio in 1730, with a modest preface of one page in Italian. Temanza, who had written a life of Palladio, tells us that he had this one plan, which I presume he lent to Cameron, and which was published with the rest in London by Charles Cameron, architect, in 1772. Views of the ruins, as they then existed, were added, and the plans of those parts still existing are given in outline, with the dimensions in English feet, as well as outlines of the decorations at the baths of Titus and Constantine, from those at the palace of Augustus and Hadrian's villa; one circular ceiling of the last was reproduced by Giulio Romano at the Villa Madama. A subsequent edition was published in 1775. Both editions contained an essay on Roman architecture, the thermæ, and a description of each one in English and French.

Octavio Bertotti Scamozzi published the drawings in folio, with a text of his own in French, in 1785.

Many of the baths are to be found in Canina; there is a monograph on the thermæ of Agrippa by Count Nispi-Landi, and one containing fac-similes of Baldassare Peruzzi's sketches of the front part of these thermæ, by Baron H. de Geymüller, which also contains the fac-simile of some sketches of the baths of Diocletian in Renaissance days. Numerous drawings of the baths hitherto unpublished are in the library of the Vatican, of the Barberini Palace, in the Uffizii at Florence, at Borgo San Sepolchro, Leyden, Berlin, and probably elsewhere; there is, too, a plan of Caracalla's baths in Serlio's book.

I must here mention that Palladio and his successors turned nearly all the thermæ upside down. The fact of the Pantheon being used as a temple, and having a portico added to it, made them believe that the laconicum was a vestibule, though in the plan of the Baths of Trajan, called by Palladio the Baths of Vespasian, it is put the right way upwards. Cameron, with praiseworthy industry, searched out many passages in the Classics, and in Mercurialis, relating to exercises, baths, and bathing; but being even less familiar than we are with these subjects, and thinking he was bound to give to every room its name and use, rather obscured than enlightened the subject.

Abel Blouet, the celebrated French architect, re-measured the ruins of Caracalla's baths, and by the aid of Count Velo excavations were made by which he was enabled to throw more light on the subject. His celebrated book was published in Paris in 1828, in which he not only gave the ruins then remaining, but restored the whole edifice. Further excavations were made by the Italian Government when Rome again became the capital of Italy, which have given us fresh information. The whole of the basement was excavated, but refilled, and hitherto no plan nor section of it has been published; nor can any information on the subject be got, although I went to Rome for that purpose. I must, however, express my obligation to Cavaliere Buongoanini for his kindness in accompanying me to these baths, and for showing me portions that are not open to the public. Since writing this, Professor Lanciani has been kind enough to send me a plan of the basement excavations that he saw.

It is necessary to enumerate the different purposes for which the thermæ were used before describing the buildings themselves. Their uses were various; they were gymnasia, *i.e.*, exercising places for the citizens, and probably included schools for learning the various exercises and sports; a theatre or grand stand for spectators to witness the contests; as well as schools for professional athletes, cloisters to walk in, open spaces for some of the exercises, gardens and alleys of trees, lecture-rooms, halls for discussion, picture and sculpture galleries, and sometimes libraries; stores of oils, perfumes, unguents, and dust for the athletes and bathers; cold, tepid, warm, hot, vapour, and swimming baths, and possibly hot-air baths as well.

To some of these baths, fresh, sea, and mineral waters were supplied. In the baths, people were oiled, scraped, shampooed, shaved, plucked, singed, pumiced, and perfumed; and in them they sometimes took refreshments,* and, seemingly, on occasions dined there. There were reservoirs for the water, shops or lodgings in the peribolus, and barracks for the vast army of slaves that attended to the bathers, the baths, the furnaces, the reservoirs, the gymnasia, the palæstra, and the grounds. Workmen to repair and foremen to direct were probably resident there, and there certainly must have been vast stores of wood and pitch for the fires, stores for oil, towels† and strigils, possibly rooms for washing and drying the towels,—even before the baths were kept open of a night and lit up, which must have required stores for the lamps, and places for cleaning and trimming them.

As long as the Roman militia was composed of yeoman farmers, who got their exercise by ploughing, hoeing, reaping, and threshing, and their drill in the Campus Martius, gymnastics may have appeared superfluous; but when Greece was known and Greek literature was studied, generals and statesmen could hardly have overlooked Aristotle's statement that the early Spartans were the best soldiers in Greece, only because they were the first to use gymnastics; and when Rome became the metropolis of the world, and civil occupations afforded no exercise, the Romans took to heart the advice that "the wise preserve their health by exercise."

We do not know exactly what the solid day was, but as the baths originally opened at the eighth hour, 2 p.m., we may suppose that it was then over. Martial thus divides the day: the

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* Being the second Royal Academy Lecture on Architecture this Session, delivered to the students of the Academy on the 31st ult. (For the previous lecture see *Builder*, p. 85, *ante*.)

* Suetonius Augustus: Letter to Tiberius, sec. 76.
† See Satyricon of T. Petronius, cap. 28, sec. 91.

first two hours for morning calls; at the third the law-courts began; Rome, he says, protracted her labours to the end of the fifth hour; in the sixth the tired rested, and all work was over at the end of the seventh. From the eighth to the ninth, he says, is enough for exercising in the palæstra, and I suppose for the bath too; at the ninth they lay down to dinner, and at the tenth he read his book to his friends. The younger Pliny tells us that his uncle always got up from dinner in daylight during the summer, and in winter as soon as it was dark. Those who wanted their water hot had done their exercises by the time the trumpet sounded, or the bath-bell rang,—for their rough way of using the word "bronze" for anything made of it leaves us doubtful, though a bell was found in Diocletian's baths.

Martial, who was a barrister, offers to meet his friend at two, take his exercise, and then bathe together; he also tells a friend, who was playing at ball when the trumpet sounded, that if he went on playing he would have to bathe in cold water.

Ball-playing was the favourite game. They certainly had four balls, perhaps five. The trigon, or little ball, stuffed with hair or wool; some think it was so called from one game being played by three players, who had each two balls, and this is said to be shown on some coins of M. Aurelius Antoninus coined at Byzantium. It was caught in the right or left hand, and he who could not use the left was not looked on as a player.

The harpastum, about which nothing is known, was considered to be a man's game exclusively, as one of the charges against Philaenis, the strong-minded woman, was that she played at the harpastum.

The pila paganica, a ball stuffed with feathers, like the old golf-ball, harder than the follis, and not so hard as the trigon.

The follis, or large hollow leathern ball, like our football, and possibly a little hollow leathern hand-ball, called follis pugilaris. The trigon, called "parva pila," or "pila," on which Galen wrote a treatise. From his description the game seems to have been that of "Catch who catch can,"—*i.e.*, aiming at one and throwing at another, with a good deal of scrambling for the ball, when it fell to the ground. He says it is the best and least dangerous of all exercises, even than bawling; and as he had been doctor to the School of Gladiators in his native town of Pergamus, and had put his shoulder out by some exercise in the palæstra, he was well qualified to speak.

Petronius, in his "Satyricon" (cap. 27), describes a game of ball with the players in a ring, Trimalchio, the bald-headed host, being one, and the other players being his slaves. The balls were green, and as soon as the one they were playing with fell to the ground it was picked up and counted, while another slave gave fresh balls from a leathern bag. The follis, or the big hollow leathern ball, with which they played at pallone, is shown on the coins of Gordianius, and it seems to have been played as pallone is now played in Rome, by striking the ball with a large guard on the right fore-arm. A blow in the chest from the ball is now considered at Rome certainly fatal, so Martial was probably joking when he says it only befits boys and old men, unless he was speaking of the follis pugilaris. Plautus speaks of kicking a man into the air like a hand-ball (follis pugilaris), and keeping him there with blows.

The regular exercises seem to have been running, wrestling, throwing the javelin and quoit, boxing, the pancratium (a mixture of boxing and wrestling), ball-playing, and jumping; but they also used dumb-bells and heavy plates of lead, the swing, climbing ropes, and indulged in dancing, holding their breath, and bawling as exercises, and also practised cutting or thrusting at a post with a sword. They, perhaps, exercised in the Coryceum; the Greeks certainly did, but what this exercise was is not precisely known, but it is believed to have been either striking at a hanging leathern sack stuffed with fig-seeds, olive-husks, flour, or sand, as our boxers do at a sack stuffed with shavings, or else it was pushed with force against an opponent, who returned it.

There was also the game of Troy, a sort of sham fight, by the boys of noble family, on horse-back. Whether any of the games were allowed to be played inside the bath proper we do not know. Celsus advises in certain cases exercise to be taken in the warm room (tepidarium) with the clothes on; but as Martial's friend, the ball-player, was outside the bath, and as the ball is mostly called dusty, we may take it for granted it was not played in the bath itself. In our English translations, "sphæristerium" is called a tennis-court, and from Pliny the Younger's letters we gather that this was covered, and perhaps warmed, in his villas at Laurentinum and Città di Castello. Suetonius tells us that Vespasian was shampooed in the tennis-court attached to the bath.

I think we may even suppose that the mosaic pavement of the gymnasium was sometimes strewn with sand, or dust, for some of the exercises.

I have taken the baths of Caracalla as the typical bath, mainly because the ruins of the central part still exist in a comparatively perfect condition, even to some of the vaulting, while the other baths have been turned to different purposes or have mainly disappeared; of some, a few ruins only remain, and what remains of Diocletian's baths forms the church of Sta. Maria degli Angeli, and also because Caracalla's baths have been so carefully restored by Abel Blouet. With a few trifling exceptions, I have shown the plan as he gives it.

I have given you drawings of all the ruins of the baths restored by Palladio, in some cases completed from the parts exposed since his days; a tracing from one of the baths at Cairo, from Pascal Coste's work; a gymnasium and bath at Ephesus, probably of Roman times, restored by Mr. E. Falkener; and a bath at Pompeii, and one in the island of Lipari, &c.

Caracalla's bath is supposed by some to have been begun during the lifetime of Septimius Severus, as bricks with his stamp on them have been found there, though this proves nothing, as we can be by no means sure that all the bricks made during his reign were used up in his lifetime. The central building was mainly completed by Caracalla in 217 A.D., though there were additions, it is believed, to the peribolus by Heliogabalus and Severus Alexander, and it was restored by Theodoric about 500 A.D.

In a book on baths, published by Giunta, Venice, 1553, a letter from Theodoric to Aloysius, the architect, on the subject of the state of the Thermæ is given. The baths of Caracalla stand nearly north and south on the diagonal; the right-hand corner looking at its front is north; the whole enclosure consists of an oblong square, with large flat apses on each flank, and is about 1,108 ft. long, exclusive of the apses, by 1,060 ft. deep, exclusive of the reservoirs, *i.e.*, about one mile round, and containing about 1,293,192 ft., or about 29¾ acres, with about 1¼ acres more for the reservoirs. A large portion of the grounds is now occupied by high-roads, vineyards, market-gardens, villas, and trattorias, and some of the reservoirs are now what the Americans would call cane-brakes; but as I am about to speak of the restored plan, I will use the present tense.

This platform is about 20 ft. above the ancient street, and is entered in front by four grand and four smaller staircases, beneath a portico extending the whole length; at the back of this portico are eighty shops or lodgings, two tiers in height,—the shops are continued a short way round the flanks, sixteen on each side. The portico stops on the flanks sufficiently beyond the shops to allow of shelter in entering each of the grand side staircases. A space equal in width to the two flights of the staircase is enclosed to form three halls, and the same width is continued as an open walk to the end. At the back of these open walks are the flat apses, each containing a palæstra and two large halls, with an open walk and a cloister at the back, and a staircase to the road outside.

In the centre of the back of the peribolus is a theatre, or grand stand (theatridion), for seeing the exercises and contests, and at its back is the reservoir, containing sixty-four tanks, about 49 ft. 6 in. long, 27 ft. 6 in. wide, and 30 ft. deep, with a cistern on the top. The whole of these tanks contain about 15,000,000 gallons of water, which was warmed in these baths by the sun, and by furnaces beneath the lower ones, which also had their sides lined with flues. At each side of the grand stand there is a palæstra, two halls, and four small rooms.

The grounds are laid out with trees and walks, open spaces, and seats, and there are shafts for lighting the basement.

The main central building is about 716 ft. long, by 367 ft. deep, with rather more than a semi-circle projecting at the back, about 164 ft. in diameter. The main building is roughly divided into three parts, *i.e.*, a gymnasium on either side, with a front and two side entrances to each. The centre, or bath portion, has also two entrances, with a large swimming-bath between them, and this seems to have been the solar cell of Ælius Spartianus. On the left of one and the right of the other entrance-corridor is a hall about 50 ft. by 41 ft.; at the front and back of this are two smaller rooms, two stories high. One of them, towards the front, contains a staircase, 3 ft. 10 in. wide, consisting of two flights with half-paces. Each hall is called in Blouet the apodyterium, or undressing-room, but is, I think, much too small for that purpose, and, if the bathers were obliged to leave their shoes, might have been shoe-rooms. One of the smaller rooms was supposed to be the elæothesium, or oil and scent store, and the other the conisterium, to contain dust and ceroma (a wax unguent) for the athletes.

The tepidarium was entered from the vestibule at each end, and was an oblong with a centre transept. It is 78 ft. 10 in. wide from wall to wall, and about 180 ft. long, with four recesses, containing baths, and with two labra or fountains in the transepts. From Celsus saying that exercise may be taken here with the clothes on, I think we must conclude that the tepidarium was used for undressing in, as Cicero says no one was allowed to go into the baths unless naked.

From the transept you enter a calidarium, cella media, or hot room, containing two baths, and from that you enter by two doorways into the huge domed laconicum, or hottest room, 116 ft. in internal diameter, with walls about 24 ft. thick. To the right and left of this principal entrance are two other entrances, both leading to a set of four rooms, the outer walls of which form the back or south-west front of the building; they are conjectured to be a hot-bath, a tepid, a cold room, and a cold bath at the extreme end, opening also into the peristyle of the gymnasium.

The gymnasium at each end consists of three halls, between the side entrances. The centre hall, with its apse, answers to the old ephebium of the Greeks, which was the training-school or gymnasium of the recruits from eighteen to twenty years of age, and was in this bath probably the school; and from the apse at the back of it there was a clear view through the peristyle, large exedra, vestibules, and tepidarium to the apse of the ephebium at the other end.

Corresponding in length with these three halls of the ephebium was an open paved space, surrounded by columns, and corresponding with each entrance is a covered portico, or cloister, returning at the back of the columns, and facing the ephebium and its halls. In the centre of this back cloister was a huge semi-circular exedra, about 80 ft. diameter, also paved with mosaic, and containing full-length portraits and colossal heads of celebrated athletes, alternating. Looking at the south exedra from the peristyle, there was a door to the right into the apodyterium, and two to the left,—the small one into the oil-store, or conisterium, and the big one into a hot-room, with a bath, probably the concamerata sudatio.

Including courts for furnaces and for light, and some very small chambers, these rooms fill the whole of this vast space, with the exception of a vestibule to each gymnasium, with a room on both sides. The vestibule and its two rooms are to the front; they are called libraries by Blouet, but were more probably undressing-rooms for those exercising, as the space between the columns flanking the entrance-halls was merely enclosed by a low balustrade of marble.

With pardonable exaggeration, Amm. Marcellinus (Valentinian to Theodosius, 370-390 A.D.) describes Constantine as saying the baths at Rome were as big as provinces.

It may give us some rough idea of the size of the central building to compare it with some of our buildings in London.

It is about 150 ft. shorter than the river front of the Houses of Parliament, and about 92 ft. deeper, exclusive of the apse.

	Square feet.
The central building of Caracalla's baths contains about	277,000
Houses of Parliament ..... 242,000 / Westminster Hall 20,800	262,800
British Museum	244,310
Law Courts	202,731
Natural History Museum	154,804
National Gallery	65,000
Royal Academy	44,928

All its covered parts were solidly vaulted or domed, its grand columns were monolithic.

Viollet-le-Duc estimates that it would cost about 13 millions of our money if built in the present day. In it were found a copy of the Heracles of Glycon, commonly known as the Farnese Hercules; the Torso, Dirce, and the Bull; Atreus and Thyestes, two athletes; Venus Callipygé, and a colossal Flora, as well as grand labra, or bathing-vessels, sunk out of solid blocks of granite or porphyry, one of which is in the Vatican and two before the Farnese Palace.

Olympiodorus says these baths had polished marble seats for 1,600 bathers. What the charge was we do not know; in Horace's time it was the fourth of an *as* (quadrans), half a farthing, and the price probably continued, for Juvenal says (Sat. 6, l, 447), "quadrante lavari." And Martial tells us they asked him 100 quadrans for a bath after the tenth hour.

There is no ancient treatise extant on the hot baths of Rome, nor on their methods of bathing. Celsus and Galen, being physicians, naturally only treat of the bath as forming part of the treatment in cases of disease. We gather, however, that the methods were much like those adopted in our Turkish baths; some went gradually from the warm room, through the hot into the laconicum; and some began with the laconicum and went gradually through the cooler rooms, and in both cases then took the cold bath. And much of the bathing was done by having buckets of water of different temperatures poured over the bathers. Some were oiled before they began to bathe, some during the process as well, and all were so after it; some, of course, with perfumed oil or unguents. Julius Cæsar left 3,000,000 lbs. of oil annually to the bathers of Rome. Before the final unction, they had been strigilled and shaved.

In Lucian, who lived in the time of the Antonines, there is a description of a public bath built by Hippias, an architect, and a friend of Lucian. In it there is no mention of the laconicum, but it gives us some notion of the way of bathing, though this bath was probably very insignificant as compared with the vast Roman Thermæ. "After you have passed a lofty vestibule, to which you ascend by a flight of steps of an easy ascent, you enter a spacious hall, proper for attendants to wait in. To the left are rooms, set apart for the company before they leave the baths, the most elegant and cheerful of any. As you advance you enter a room, not wanted in the baths, but appropriated to the more opulent. After which, on both sides, are places for your clothes, the middle of this room is exceeding lofty, very light, and contains three lavacra, of cold water, ornamented with Lacedemonian marble; in the same room are marble images of ancient work, one of Health and another of Æsculapius. As you go out of this room, through an oblong vaulted passage, the house grows sensibly warmer, although the heat is far from being disagreeable; this passage leads to a very light chamber on the right hand, where you may be supplied with unguents; this room likewise has a communication with the Palæstra, and both sides of the door are cased with Phrygian marble.

The next apartment is the most beautiful of any yet mentioned, being resplendent with Phrygian marble to the very ceiling; in it are many conveniences for sitting; it is also sufficiently extensive for walking, or taking exercise. On going out, you enter a hot passage, long enough for a race, and encrusted with Numidian marble, which leads you to a very elegant and light room, painted of a purple colour; in it are three warm baths. After having bathed you need not return by the same way you came, but slowly by a shorter way, which brings you to the cold bath through a warm room, gradually decreasing in heat. All these rooms are exceedingly well lighted from the top.

Hippias has wisely constructed the room which contains the cold bath so as to front the north; the other apartments, which require a greater degree of heat, he has exposed to the south, south-east, and west."

The Romans had no thermometer, so we cannot tell what the precise heat was, but the water seems to have been hot.

Athenæus gives the following lines (lib. 1, cap. 32):—

> "Plague take the bath! just see the plight
> In which the thing has left me;
> It seems t'have boil'd me up, and quite
> Of strength and nerve bereft me.
> Don't touch me, curst was he who taught a
> Man to soak in boiling water."

That stoic philosopher, Seneca,—whose business Macaulay describes as being "to declaim in praise of poverty, with two millions out at usury; to meditate epigrammatic conceits about the evils of luxury in gardens which moved the envy of sovereigns; to rant about liberty while fawning on the insolent and pampered freedmen of a tyrant; to celebrate the divine beauty of virtue with the same pen which had just before written a defence of the murder of a mother by a son*,"—was very severe on the heat of the water in the baths, and says "it is hot enough to boil a naughty slave in."

Both Martial and Celsus describe the heat of the laconicum as dry heat. If the heat was anything like that of our Turkish baths, from 230 deg. to 300 deg. Fahrenheit, and there were water in it, the bathers would, I should think, have been scalded to death with the steam.

I read an account of a fire-king at a country fair who remained in a hot room till a fowl was cooked, and then ate it. A chemist who happened to be there, and had ascertained that there was no trick, thought it over, and concluded that the heat was possible to be borne from the air being dry; next day he inserted unseen a bowl of water, and shortly afterwards the fire-king burst open the door, half scalded to death.

The recesses round the laconicum, *i.e.*, in the thickness of the wall, are paved and lined with white marble slabs, and have seats. One that remains looks like a water-bath, though I saw no exit, but some believe that they contained no water, but were used by old bathers, who could not get heat enough in the room; for they must have been hotter, as, in addition to the hanging floor, the walls were lined with flue-pipes. In Pliny the Younger's letter to Romanus he tells us that Macedo, a person of Prætorian rank, whose father was a slave, was trampled to death by his servants, who "threw him upon the burning pavement of the hot bath to try if there was any remaining life in him."

Many think that the Roman method of bathing is still adhered to in the East. I can give you my experience of bathing in one of those in Cairo; and I trust the ancient Roman ones were not so offensive to the sense of smell.

I was first ushered into a vast hall, lit by a lantern, with a raised seat for the bath-keeper, and a baldachino over the coffee-stove, with a fountain in the middle of the hall. The whole hall was gorgeously painted, and had towels drying on the tie-beams, which the attendants hung up and took down by means of long bamboo poles. A little above the main floor were a series of carpeted compartments, each as big as a small room. Here I undressed, and wrapped myself in cloths, while my interpreter folded up my clothes, and tied them up in a sheet. I was then led by an attendant across the hall to a dark passage, and was ushered into a darkish hot room, where I sat on a marble seat, and I was gradually moved from room to room, each of which was hotter than the last, until I was taken into a light domed-room, with a central peristyle, in the middle of which was a large steaming tank of water, with steps running down into the water. The walls were lined with white marble, inlaid with coloured ones in patterns; the domed porticoes of the peristyle were plastered, and lit by star-shaped openings, several in each dome, the space between each arch and the wall being domed.

Within the marble margin of the bath was a gutter. I was laid down at the side of it, rubbed with a horsehair glove, and then soaped over and scraped with a sort of artificial sponge, composed of dried grass resembling diminutive bamboo. I was then washed by hot water being poured over me from a large copper cup, and when this was finished I was made to walk down the first step, and sit down with my legs in the water, which was nearly scalding. I was then made to sit lower and lower, till I was up to my middle; the attendant then went into the bath, caught hold of my hands, and jumped me into the hot water, and put my head under it several times. I was taken back by the passage into another darkish room, where two marble basins, projecting from the wall, were running over with hot and cold water; water was dashed over me from a cup, at first hot, afterwards tepid, and at last quite cold, and I was then led back to the place where I undressed. I was then dry shampooed, and every joint in my body cracked, including my back bone, both backward and sideways.

The Egyptians had their heads shaved, their beards combed, their nails cut, and their feet rasped. After my dry shampooing I was covered up, laid on a cushion, given a cup of black coffee, and a narghiley. I felt quite refreshed, and ready for dinner, though I had started at 2 a.m. that day, and been up the big Pyramid, and into the King and Queen's Chamber, and had a long ride back.

As I think we know enough about the exercises, and all I can tell you about the method of bathing, I will go back to the plan.

I am inclined to think that the four rooms on either side of the laconicum, as well as the hot bath in the Gymnasium itself, were mainly set apart for the professional and amateur athletes, though they could be taken if desired by the ordinary bather, though I beg you to observe that if this were done, the bather would have to run naked through the gymnasium, possibly crowded with people, to get back to his clothes in the Tepidarium, unless he went back through the hot room again, and rendered useless his last cold bath. A grand stand 550 ft. long, with many rows of seats, which would probably hold 1,300 spectators, had probably a good many couples of combatants in front of it before the races began, and many of the amateurs may not have cared to exhibit; and all these men were covered with ceroma and dust; there might, too, have been an objection by the professionals to bathe with the ordinary bathers, or *vice versâ*.

We, unfortunately, know hardly anything about the plan of bathing pursued, for Professor Middleton declares the picture from the Baths of Titus to be a Mediæval forgery, made up from Vitruvius.

These two curious oval rooms show no trace of having been vaulted, and being connected with the Elæothesium, may have been used for oiling and dusting the athletes, or have been used as a sun-bath. Almost every Roman was oiled and walked in the sun naked every day for the sake of his health. In the head of each of the four niches there is a terra-cotta pipe that looks about 9 in. in diameter, and these seem to point to douches or cascades. I may also add that the small vaulted chambers at the back of the prefurnium, two stories in height, called reservoirs in Blouet, bear no traces of water, whereas the tanks of the main reservoir show the deposits of lime on the plastering.

I think all the architects here will agree that the plan is a very pretty-looking one.

When we begin to examine the plan for evidences of the construction, we cannot fail to observe that the Tepidarium is strongly abutted at four points on each side. Towards the swimming-bath, these piers on either side of the transept are 54 ft. 1 in. deep, 12 ft. wide at the thinnest point, except where they are hollowed out by the niches, 24 ft. 7 in. at the thickest, and 19 ft. in the Tepidarium. They are nearly as strongly abutted on the other side, and there are enormous buttresses above with an archway through them to resist the thrust of the great vault of the Tepidarium, just as there are on the Basilica of Maxentius, to resist the thrust of the nave vaulting. I may add, too, that the vault of the Tepidarium had pumice-stone for its matrix, while the other vaults had merely tufa. Palladio and Blouet leave the swimming-bath open, and Viollet-le-Duc supports this view; but Professor Middleton says he found masses of vaulting on the pavement, and believes that it was vaulted. I think these must have been pieces from the vaults of the entrance vestibules.

I cannot help appearing to digress here. Ælius Spartianus (297 A.D., reign of Maximinianus), who wrote the life of Caracalla, says, "he left exquisite hot baths, which bear his name. The solar cell of which the architects say, cannot be made by any imitation, in the way in which it was made; for cross-beams of brass or of copper are said to have been placed on the top, to which the whole ceiling was entrusted, and so great is the span as to make learned mechanicians say that this very construction is impossible." The first question was, where was the solar cell? the pieces of fallen vaulting show that the cupola of the laconicum was of rubble or concrete. The outer wall of the swimming baths shows a strip of rubble on its inside face, about the depth of the cornice of the large columns, much too shallow for a vault, and the brick-facing exists both above and below this, but even were this strip deep enough for a vault, none could have existed on account of the thinness of the wall.

I had written to Lord Savile, our late Ambassador at Rome, about these swimming-baths, but the reply came before my return from Rome, which he, too, had left. With a kindness with

* "Lord Bacon," Macaulay's Essays.

which I am deeply touched, he wrote to Professor Lanciani, who had visited the Piscina during the excavations (1871 to 1873), extracts from whose letters he sent me, and from those it appears that tons of rusty T-shaped iron were found in the excavations, which he says were bolted together in the form of a St. Andrew's cross. These beams seem to have been the cores of the brazen girders; the roof appears to have been flat, and partly covered with concrete made of light pumice-stone, in which iron rods, about 2 ft. 6 in. long with T ends, were imbedded. It seems by no means impossible that there might have been hypæthræ, open, glazed, or covered with glazed skylights, in the concrete roof. As the clear span is 76 ft. 10 in., and the roof was flat, we must not boast too much of our skill in the use of iron. I must conclude this description in my next lecture.

ARTIFICIAL ILLUMINATION.*

The three subjects of lighting, heating, and ventilation are so intimately connected that it is well-nigh impossible to separate them. In their combination, however, they form a subject so vast, and with such extensive ramifications, that it would be utterly impossible to discuss it in a single evening. I must warn you, therefore, at the outset, that I shall limit myself almost exclusively to illumination, and shall only allude indirectly to heating and ventilation. I will not weary you with any attempt to explain the undulatory theory of light, or to show that the phenomena of light are more easily explicable on that theory than on the emission theory, which obtained for many years. All that it concerns us to know now is that any body, when raised to a temperature higher than that of the surrounding air, begins to part with some of its energy, in the form of radiations. At low temperatures these radiations affect our sense in the form of heat alone, but when a temperature of something like 525 deg. Centigrade is reached, the radiations begin to be perceptible as red rays. With increasing temperature the radiations affect the retina, as yellow, green, blue, and violet rays, and when these are produced the combined effect is white light. It should be stated that nearly all bodies are fused before they can be raised to such a state of incandescence as to give off white light. The light which we enjoy and use, whether natural or artificial, comes, to a very small extent, directly from the light-giving body itself. On an ordinarily cloudy day we get sufficient light for all practical purposes without seeing the sun at all, and even when he is shining, every cloud, every hill, every building, and all the waving branches of tree and shrub catch and reflect back to us the light of the great luminary himself. Precisely the same thing occurs indoors with artificial light. This room is now amply lighted by the burners under the dome; but if the walls and ceiling were lined with black velvet, or some such substance, which would absorb and not reflect the rays of light falling on it, the dulness and darkness which would result would be astounding. You should, therefore, always endeavour so to arrange the positions of your points of light that they may have the maximum effect upon reflecting surfaces. Another point to be borne in mind is that upon the purpose for which any room is required depends the kind of illumination which should be given it. In a dining-room or billiard-room, for instance, all the light requires to be concentrated on the table, and the remainder of the room may be in comparative darkness, and the same thing applies where very fine work is done, and when the workman wants a concentrated light; but in the majority of cases a diffused light is required, and wherever it is practicable the flame itself of the burners should be hidden. I know of no more pleasant method of lighting than that adopted in the House of Commons, where all the gas-jets are placed above the ground-glass of a ceiling skylight. In this case the artificial light enters in precisely the same way as the natural daylight, and the eye is never wearied by the direct rays of a burner.

Now, with regard to illuminants themselves, leaving out of account for a moment the electric light, the light-giving flame from all of them is produced, not by the heating of any solid material to incandescence, but by heating gas to a high state of ignition. Whether we use tallow, wax, oil, oil-gas, or coal-gas, in every case the light depends upon the existence in these substances of carbon and hydrogen, and upon the substances themselves being heated so that the gases pass off and become ignited in the presence of oxygen. The only difference between gas-lighting and other forms of illumination is that, in the one case, the gas is generated at a distance from the point where it is to be burnt. In the case of an ordinary candle it may seem strange to say that its light is due to the ignition of gas, but it can easily be shown that this is the case. The wick is only the vehicle for conveying the gas to the point of ignition, and the smaller the wick the better the light given will be. The flame of a candle, or of an oil-lamp, or of a gas-burner consists of three parts,—(1) the inner dark zone of unconsumed gas, (2) the luminous area, where the solid particles of carbon are being burnt, and (3) the outer zone, where the supply of oxygen is greatest, and the carbon is at once turned into carbonic acid, which is, of course, given off into the room. It is impossible to prevent the formation of carbonic acid, but the whole object of manufacturers, whether of oil or gas lamps, is to arrange the burners so that as little unconsumed gas as possible escapes, as this is all waste. As reference is frequently made to the illuminating power of oil-lamps or gas, it is as well to know that the legal standard of illumination in England is a sperm-candle, burning in properly-sheltered situations 120 grains of spermaceti per hour, and this is known as "one-candle power." In France, the standard is a Carcel lamp burning 42 grammes of pure colza-oil per hour, which is equal to about 9·6 candles.

When gas was introduced, all the oil-merchants and the lamp-makers raised an outcry that their trade would be ruined, much in the same way that the announcement of Mr. Edison's discoveries in electric lighting sent down temporarily the value of the gas companies' shares. As a matter of fact, the introduction of any new illuminant has two effects: first, it makes the public want more light; and, secondly, it puts the purveyors of the old on their mettle, and immediately they set to work to improve the old forms of burners. I should imagine that, notwithstanding all that gas has done and that electricity has done, there is more oil used for illumination at the present day than ever before, and the improvements in the way of burning oil are as great as those which I shall shortly mention with regard to gas. The oils used in lamps are either what are called the fixed fatty oils,—such as sperm, colza, and others,—which undergo destructive distillation, and are resolved into gas; or the fluid hydrocarbons obtained by the distillation of petroleum and various other substances. These are called the mineral oils, and they give off inflammable vapours which in badly-arranged lamps are frequently the cause of explosions. The earliest form of lamp was probably merely a shallow vessel, with a wick floating in the oil, and the first improvement was in making a chamber for the burning wick separate from the main body of the oil. Roman and other lamps of this sort can be seen in nearly every museum. The wick was generally circular and solid, and consequently it sucked up oil throughout its whole substance, just as much at the centre as at the circumference; but, as the air could not get access to the flame at the centre, there was very imperfect combustion there, and much smoke and unconsumed gas were given off. This kind of lamp continued in use for centuries, and the result must have been dismal in the extreme. The first improvement consisted in having flat wicks, in which a much greater surface of cotton was exposed to the air, and, consequently, much less unconsumed gas was given off. It must be borne in mind that one of the most important points is to regulate the air-currents which support combustion, and I do not think it was till the eighteenth century that the contrivance of a sort of cone of metal was adopted, which was placed over the burner itself and had a slit in it rather larger than the mouth of the wick-holder. The air was introduced below the burner, and was directed against the sides of the flame, which would rise over the slit; slight variations of this form are now used in all kinds of lamps. In 1784 the invention of M. Argand was patented in England, and this form of burner must be so familiar to you all that I need only describe it very generally. It consisted of a hollow circular wick, and the air was introduced into the centre of the flame as well as to the outside, so that far more perfect combustion took place. With both kinds of burners some arrangement for protecting the flame from outside currents of air is necessary, and in the first form of the Argand a metal cylinder came down over the top part of the flame; but it was very soon found that the best plan was to have a glass chimney, and, with slight alterations, this lamp has continued in use till now, and still holds its own as it has been adapted to gas. The most recent improvement in oil-lamps with which I am acquainted is a slight modification of the Argand burner, manufactured by Messrs. Jones & Willis, and called by them the "Cathedral" lamp. In this the wick is circular, and there is a hollow tube conducting air to the centre of the flame, but the burning wick itself is not introduced into the oil, but is closely clasped to a separate set of cottons. Several other forms of this lamp are made. I must utter one word of caution with reference to this and any other invention that I may notice in this room. It must not for one moment be supposed that I am instituting invidious comparisons, that I consider the burners which I allude to as absolutely the best, or that I wish to throw the slightest discredit upon any that I do not mention. It is absolutely impossible to make oneself acquainted with all new inventions, and I merely call your attention to what seems to me good, leaving you to make your own investigations as to what is best.

During the last few years several methods of burning the heavy hydro-carbon oils without the intervention of a wick, and also without reducing the oils to a gas, have been invented. These oils are obtained from coal-tar, crude petroleum, and the waste products of chemical manufactories, gas-works, &c., and are, consequently, very inexpensive. The "Lucigen" was, I believe, the first in the field of these inventions, and it is certainly a wonderful light for any open-air work, where noise is not objectionable. The general principle of the light is that oil is forced by compressed air or steam through a very small nozzle, which is surrounded by another nozzle, through which air at a pressure of 15 lbs. is forced. Immediately above these nozzles is a large chamber, and the sudden expansion of the air divides the oil into a very fine spray, which is easily ignited. The air passes round the burner in a spiral pipe before it reaches the combustion-chamber. It is, of course, necessary with this light to have a means of supplying compressed air, but this can be very easily arranged in building works of any magnitude, as here steam-engines are almost invariably employed.

"The Wells Light" is on a somewhat different principle, no machinery for supplying compressed air being required. The oil-tanks are very much like those of the "Lucigen" light, but they are fitted with a hand-pump, so that oil can be pumped in until the air which was in the tank is compressed to about 25 lbs. pressure. Just under the burner is a little tray, in which tow or some such material is placed and ignited when the light is wanted. As soon as the burner is heated the oil is turned on, and by the heat is converted into gas, and can be ignited, and the flame itself keeps the burner hot. The advantage which the "Wells" has over the "Lucigen" is that it is much more portable, and can be carried to places where it would be almost impossible to obtain a supply of compressed air, such as the "Lucigen" requires. The quantity of oil which is consumed by these lights is about two gallons per hour, and the cost is not more than 2d. a gallon; but, of course, the expense of keeping up the air-supply must be added to this. In any case, however, this is a very ingenious way of securing an extremely powerful light, of 3,000 or 4,000 candles, at a very small cost.

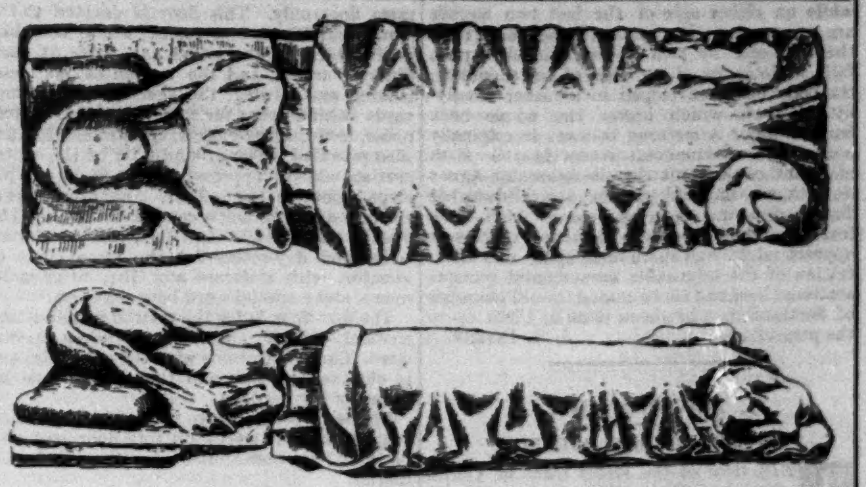
To turn from oil to ordinary coal-gas, there can be no doubt that we now get a far higher value of light from the gas which we burn than was the case ten years ago. We all of us remember the burners which roared whenever they were turned up high, unless the pressure happened to be very low, in which case it was well-nigh impossible to see to read. The improvements made have been twofold,—firstly, in the shape of the burner itself; and secondly, in the internal construction of the burner, making it self-regulating as regards pressure. Messrs. Sugg have always been foremost in the field in these improvements, and after a great many experiments they have arrived at what they consider the best form for a flat-

* A paper by Mr. John Slater, B.A., F.R.I.B.A., read before the Architectural Association on the 3rd inst., as elsewhere mentioned.

flame burner. When gas issues from a small opening at a greater pressure than is suitable for it, not only is roaring produced, but also more gas issues from the burner than can be properly consumed. Mr. William Sugg made the discovery twenty years ago that as the rate of velocity of the gas issuing from a burner increased, the illuminating power per cubic foot diminished. Hence the efforts of manufacturers were directed to regulate the pressure by an arrangement inside the burner itself. This has been done in all sorts of ways. The Peebles burner, the Parkinson governor, Sugg's steatite float-governor, among others, may be mentioned. Innumerable experiments have been made to determine the best form of the slit at the top of a flat-flame burner, and the best material for making the burner. Messrs. Sugg's circular slit table-top burner is now considered the best. The material now generally employed is steatite, a mineral of a soft, soapy character when in its original state, but which, after being burnt in a kiln, becomes harder than steel, and practically indestructible by heat up to over 2,000 deg. F. A good form of burner will give sixteen candles for a consumption of 5 cubic feet per hour. The Argand gas-burner, which is almost exactly like the ordinary oil Argand, now gives considerably over sixteen candles for every 5 cubic feet consumed. Some few years ago a new method of burning gas was invented, and I believe the late Sir W. Siemens was the first to introduce it in what he called the Siemens regenerative gas-lamp, of which the "Wenham," the "Cromartic," and the "Meteor," —a German invention,—are modifications. In these burners the gas, instead of issuing from the burner in an upward direction, issues downwards from a number of very small apertures, and the flame curls over either in an outward or an inward direction. The flame is screened from the ordinary air-currents in the room by a glass shade under it, and the air for combustion is conducted to the flame through small holes well up above the light in the frame of the lamp itself. These lamps adapt themselves admirably to the ventilation of rooms, as, by means of a pipe or metal shaft above the ceiling line, all the products of combustion and all the vitiated air of rooms can be drawn off. Much more might be said of these burners.

In a quite recent invention Messrs. Methven & Sugg have improved upon this, and they have now perfected an arrangement by which the burning gas has a separate supply of air all to itself. This air is first dried,—as it has been found that water vapour in ordinary air is a great bar to obtaining the full illuminating power of the burning gas,—and then supplied to the flame at a pressure very slightly in excess of the ordinary atmospheric pressure. It is necessary that separate pipes be laid on to the burners for the supply of air, and that some means of obtaining the requisite pressure be at hand, so that for ordinary rooms and small installations the cost would probably be too much, but in large buildings where crowded audiences assemble the system would be invaluable. It can be seen in operation by any one who is interested in the subject at Messrs. Sugg's works, Regency-street, Westminster. Another form of gas-burner is exemplified in the Welsbach incandescent light. This, or a modification of it, was first shown at the Gas Exhibition at the Crystal Palace in the winter of 1882-3. In this a mixture of gas and atmospheric air is used, which burns at a high temperature, but itself gives out very little light, but it heats a thin framework of magnesia or some other substance to a state of incandescence, and gives off a very steady, pure, white light, with one very great advantage, that there is no smoke from the gas. The drawback is that the framework, or envelope, requires periodical renewing, because it is impossible to prevent it oxidising when burning in air, and unless it is very carefully made, small particles frequently fly off and fail. The Lewis incandescent lamp was on the same principle, but here a thin coil of platinum wire was brought to a state of incandescence.

You are all aware of the greatly-increased brilliancy of any burning body if plunged into oxygen compared with its light if burning in air only. Quite recently a method has been invented of combining oxygen with gas or with an oil flame, and burning the two together. The oxygen is stored in receptacles of various sizes, and is led to the point where the light is required in very small tubes; a separate tap turns on the gas and the oxygen, and when they mingle an intensely white light is produced.



Monumental Effigy in the Church of Airth, Stirlingshire.

This is augmented by having a small block of some substance which can be brought to a state of incandescence suspended over the flame. This light is, I think, quite equal in brilliancy to the electric arc-light, but whether it will prove a commercial success I am somewhat doubtful, because of the increased difficulty and expense of leading a double set of pipes to the burners, and of having ready a supply of oxygen. But this difficulty is, of course, much less than that of supplying electricity, and I can very well believe that in many cases such a light would be invaluable.

The energy of chemical affinity is the cause of the light of all the illuminants which we have hitherto been considering, and I must now say a few words of the other great source of light which was discovered and shown as an interesting experiment nearly eighty years ago, and which, in the last ten years, has made such enormous strides, viz., the energy of current electricity. The science of electric lighting divides itself into two parts,—first, the production of the current, and second its conversion into light.

Electricity can be produced either by chemical or by mechanical means. If two dissimilar metals, such as zinc and copper, be immersed in some acidulated water and connected by a wire, a current of electricity passes through the wire from the copper to the zinc, and this forms a simple cell. A number of cells combined form a battery, and if the battery is strong enough, a thin conductor when brought into contact with its two poles can be made red or even white hot. In Sir Humphry Davy's experiment in 1810, 2,000 double plates of copper and zinc were employed, and when the wires connected with the two poles of this battery were attached to two pieces of carbon, and the circuit was completed, on the pieces of carbon being separated a brilliant light was produced. Dr. de la Rue connected together 14,000 cells, and obtained most powerful currents; but these cells were very expensive, and if electric lighting had to depend upon voltaic batteries it would never have reached its present development. Oersted's discovery of electric magnetism in 1819, followed in 1830 by Faraday's discovery of induced currents, led to the construction of machines which produced electricity by mechanical means, viz., by revolving coils of wire between fixed steel magnets. These machines were called magneto-electric. In 1867 came the great discovery which revolutionised everything, viz., that the residual magnetism in any piece of soft iron that had once been magnetised is sufficient to induce feeble electric currents in a coil of wire, which current can be made to react on the iron and then again on the coil until the intensity of the current reaches a very high pitch. This did away with the necessity of using steel magnets, and led to the invention of the numerous kinds of dynamo machines which we now see. Generally speaking a dynamo machine consists of (*a*) the field magnets; (*b*) the revolving armature; (*c*) the collector; and (*d*) the brushes for leading off the current to the external circuit. The motive-power for driving the dynamo can be obtained from water, gas, or steam. In order to obviate the very practical difficulty of being obliged to use the electrical energy as soon as it is produced, and consequently being dependent for the light upon the regular running of the machines, accumulators and storage batteries have been invented, and these form a reservoir of electrical power which can be resorted to whenever it is necessary. No electric light installation, public or private, should be considered complete without sufficient storage capacity to dispense with the engines for several hours.

Now as to the conversion of the electric current into light. The current is the result of the expenditure of energy, and consequently has potential energy in itself, or, in other words, it can be made to do mechanical work. When a current is traversing any conductor, it meets with a certain amount of resistance, in overcoming which heat is developed, and if the current be strong enough, the hot body becomes incandescent and gives off light. In the arc-lamps a powerful current is sent through two rods of carbon, which are in contact, and the ends burst into flame. By various mechanical and electrical contrivances the ends are drawn slightly asunder, and the voltaic arc is produced, and as the ends wear away the rods are continuously being brought close together again. In the incandescent lamps, on the other hand, a thin thread of carbon is inclosed in a vacuum, and the current passing through it heats it to incandescence. No oxidation takes place, and many of these lamps will last 2,000 hours.

The distribution of electricity for general purposes of illumination is a subject of such magnitude, and so complicated, that I prefer leaving it untouched rather than giving a hasty and incomplete sketch of it. It is *the* great question of the day, and very various opinions are held as to the best means to be adopted to overcome the recognised difficulties in the way of general distribution from central stations. The enumeration of these difficulties would take some time, and the discussion of them the whole evening.

To conclude, gentlemen, you may be certain of one thing, which is, that with electric lighting, just as with gas, oil, and other methods of illumination, there are good methods and bad ones, and it behoves you, in the interests of your clients and those for whom you act, to make yourselves acquainted with the improvements that are daily being made, so that you may not be at the mercy of the specialists whom you have to employ.

[Some notes of the discussion which ensued are held over, for want of space this week.]

MONUMENTAL FIGURE, AIRTH CHURCH, STIRLINGSHIRE.

THE figure given presents an interesting artistic development of a type of treatment lately illustrated in the *Builder* (Oct. 13, 1888), from Wittlesea Church, in Cambridgeshire, and from Castor Church, in Northants. An illustration from which this is drawn appeared in the first volume of the Proceedings of the Society of Antiquaries of Scotland, in connexion with notes [on the Church of Airth, by Major Robert Bruce Armstrong, who there states that it lies in the eastern part of the building, and is a semi-effigy of a female, 6 ft. 3 in. long, by 1 ft. 10 in. broad; that it rests on a couch, the head on a cushion, the hands placed together on the breast, "a heavy covering folded back, falling in artistic folds on each side and over the end of couch, covering the figure from the waist downwards,

while on either side of the feet two hounds are represented. The headdress, held back from the forehead by two spherical-headed pins, falls in folds on either side of the shoulders, the body being enveloped in a rather closely-fitting dress which leaves the whole neck bare." Major Armstrong believes it originally occupied a monumental recess in the Airth aisle, and conjectures that it represents Agnes de Erth, who married, prior to 1414, "Edward de Brus." She was alive as late as 1468. The learned and able society in whose reports it appears might well spare more space and illustration of the admirable monumental remains scattered here and there among the old churches of Scotland than has been done by them up to the present time. J. T. Irvine.

Illustrations.

CHRIST CHURCH COLLEGE.

THIS view of the street front of Christ Church College, Oxford, founded by Wolsey, and completed afterwards under the architectural direction of Wren, is reproduced from one of the pencil drawings made by Mr. John Fulleylove for the work in illustration of Oxford, a notice of which appeared (along with another illustration) in the *Builder* for Jan. 5 of this year.

As in the former case, the reproduction here given is on a larger scale, and more nearly represents the effect of the original drawing than the smaller reproductions in the work referred to.

ST. PANCRAS WORKHOUSE.

We illustrate this week the plans prepared by Mr. H. H. Bridgman, architect, for a rather extensive rebuilding of the St. Pancras Workhouse in King's-road, N.W.

When these buildings are erected there will only remain the rebuilding of the laundry block and chapel, all of which are included in the architect's scheme of remodelling the workhouse.

The plan indicates the old, the last erected, and the proposed new buildings. The blocks comprised in the tenders recently submitted,—and of which Messrs. Kirk & Randall's was the lowest, viz., 66,321*l.*,—are those marked AA, BBB, C and C^{a}, D, E, F, G, and H, the corridors connecting the same, new system of drainage, division walls, and paving the surfaces.

The site of the workhouse proper is about four acres and a half in extent, and at present contains about 1,565 inmates, and the Cook's-terrace block adjoining 405 more, or a total of 2,070. The new plans provide for accommodation for 192 additional inmates,—giving a grand total of 2,262,—and will effect the reconstruction of the old buildings long since demanded by the requirements of the Local Government Board. Most of these old buildings were erected when the workhouse was first laid out in 1809.

At various times reconstruction has taken place, the more recent work being the women's and children's block, the kitchen and dining-halls, and the Cook's-terrace block, all by the same architect, the last of which was erected in 1885. Block K and the infirmary were erected about thirty years ago. The final work will be the removal of the present dilapidated laundry block, already referred to, a part of the space being utilised for a new laundry, &c., and the remainder, probably, for a chapel, as planned.

The workhouse ground has two different levels; the front angular portion slopes from the King's-road to the front of an existing block, covering a part of the ground where the main Block, B, is to stand; the rear portion is much higher than King's-road, giving a difference of about 9 ft.

The old building being removed, the ground will be excavated back to and including the area in rear of the new main block, with a slight incline of about 3 ft. only from the new entrance in King's-road.

The first block, A, will contain the probation wards, two stories in height, for men and women respectively, each side being classified in sections, with waiting-rooms, baths, &c., as required, and warmed with hot water. The lodge and ambulance-room are in the front, immediately inside the principal entrance; a store-room for inmates' own clothes being provided under the entrance.

The main block, B B B, is 423 ft. long, and consists of three blocks connected on the basement floor only. This floor is devoted to the stores and labour-test rooms, where the able-bodied men in the house can work at their different trades, and the women at mattress-making and sewing, the sheds in the airing-yards behind being for wood-chopping. Lavatories, baths, water-closets, trade stores, &c., are also provided. The ground-floor of the centre portion, which is approached by a flight of wide steps, contains the offices, committee-rooms, master's quarters, and a central staircase. The double wards, right and left, are the dormitories and day-rooms for the same class of inmates, with staircase and lift, attendants' rooms, and a special ward between them.

The first-floor is for the matron and assistant medical officers' apartments, and a special ward. Communications with the side buildings is obtained on this and the upper floors by means of iron bridges.

The second-floor centre portion is for married couples, and the wards on this floor will also be used as dormitories for the aged and infirm.

The third-floor will be occupied by aged women in the centre, and by bedridden inmates in the side blocks.

The fourth-floor, in the centre, will be for the attendants' rooms, and the side wings for bedridden inmates.

The lavatories and baths are in the annexes, and are supplied with hot and cold water.

The wards are supplied with hot-water warming apparatus, as well as with open stoves. Bay windows are introduced to all wards in front, to add to the cheerfulness of the same. The first-floor throughout is constructed of fire-proof materials.

Fire hydrants and hose are supplied to each landing, and stand-pipes and hydrants are fitted in the areas both in front and rear, all attached to the New River mains. The stairs, landings, and corridors throughout, are either in stone or concrete. There is a large cast-iron water tank high up in the tower, which can be supplied both by the New River Company's water main and from the workhouse well. The water is then conveyed to the several tanks or the annexes and other w.c.'s, draw-offs, &c., by gravitation.

The construction of the floors of the wards generally is by means of two longitudinal double-wrought iron girders and cross-trees to the side walls, the whole resting on tiers of circular cast-iron columns. The ward floors are of wood, except the basement-floor, which is of wood-block flooring and asphalte respectively.

The two blocks C and C^{a} are for aged and infirm men, and are four stories in height, the ground-floor being used as day-rooms and the three upper floors as dormitories, with attendants' rooms, bath-rooms, stores, w.c.; annexes and bay-windows, water arrangements, fire hydrants, and other apparatus, are provided similar to the front main block. An additional external iron escape-staircase is constructed at the opposite end of each block.

The ends overlook the St. Giles and St. Pancras Burial Grounds, which are laid out as a public garden, and are together about 7 acres in extent; the bay-windows, therefore, will enable the inmates to see the gardens from any part of the wards.

Between the two last-named blocks is the male imbecile block, C, two stories in height, with day-room and dormitory on each floor, with the necessary attendants' rooms, stores, baths, lavatories, and padded-room.

The water, warming, and fire-supply arrangements are as before described.

The male infectious block, E, is situated in the eastern corner, as isolated as the site will permit of, and is two stories in height. It has two entrances, to admit of sub-division, and is fitted and finished in a similar way to the last block.

Block F is for female imbecile wards, and is three stories in height for subdivision, with the necessary attendants' rooms and accessories as before described, and is finished and fitted in the same way as the male imbecile block.

Block G contains the female infectious wards, two stories in height, and similar in construction and appointments to the male infectious block.

Block H comprises the stable and coach-house, and is planned for four horses, two carriages, and two hearses, with harness-room and corn-store at either end of the stable, and corn-loft over. A lodge is also placed at the back entrance, with a weighing-machine in the roadway. Coals, flour, butcher's meat, and other heavy stores enter by this gate. Adjoining the gate is placed the severer labour test cells for stone-breaking by the rougher able-bodied class, also a carpenter's workshop, and a timber-shed and coffin-store.

Most of the walls internally are finished in stucco for painting or colouring; some portions are finished with dinging on the brickwork, and then simply coloured. The covered ways, opening at the sides, connect the whole of the buildings, and cross-ways communicate with them from the dining-halls and kitchen, and three bridges span the back area of the main block, connecting them to the main building.

The covered ways, areas, and ground surfaces of the airing-grounds are finished with Hobman's tar-paving, laid to a good fall.

Two main lines of pipe drainage, laid parallel with the covered ways, take the drainage of the several blocks and ground-surfaces; these join a third line of twelve pipes behind the front main block, and a fourth in front of 9 ft., taking the several down-pipes, the whole being intercepted by a 15-in. pipe-drain passing under the main block; and, after connexion with the drainage from the stables and probation blocks, discharges into the main sewer in King's-road, with a good and regular fall the whole distance.

The workhouse, which provides for a parish with a population of considerably over a quarter of a million, is admirably situated, being surrounded on three sides with streets, and with considerable open space beyond, and on the fourth side by the gardens referred to. The Vestry-hall of the parish stands on the south-west corner of the site, separating the workhouse from the cooks' terrace block. There is some talk of the Vestry-hall being removed, and rebuilt on a more commodious site elsewhere.

The laundry block would be four stories in height; in the basement there would be five steam boilers. The basement of the chapel would form the engine-house and stokery, from which latter the boilers would be worked. There would be a skylight immediately over the fronts of the boilers, and an area on either side for light and air. On the ground-floor of this laundry, on either side of the central chimney-shaft and staircase surrounding it, would be the receiving-room and delivery-room respectively for the soiled and clean linen.

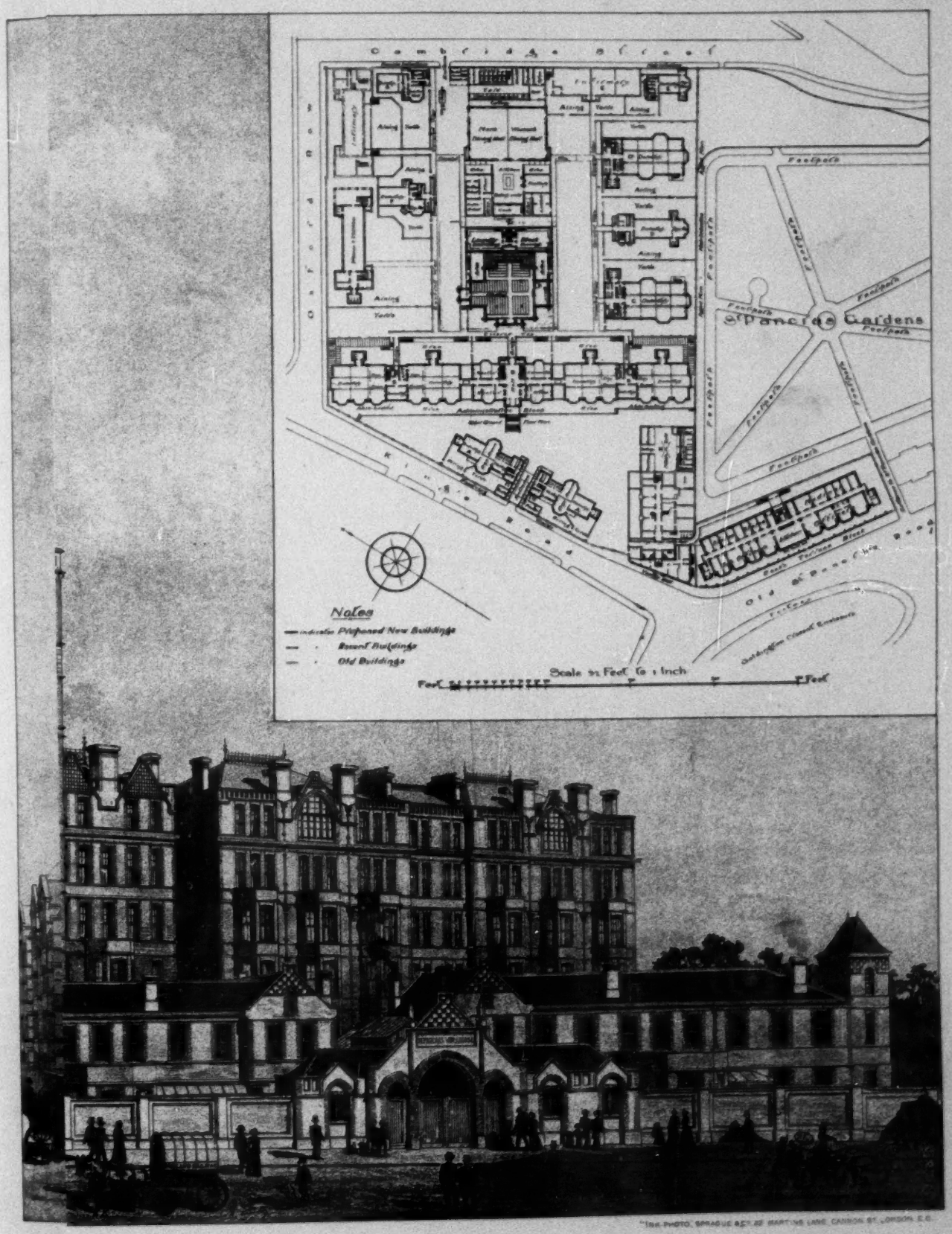
The linen would ascend and descend to the several floors by means of lifts. On the top floor of the building would be the washhouse, with a louvre roof for the emission of steam. The soiled linen would be first sent to this floor from the receiving-room, which would be fitted with the necessary washing and wringing machinery and appliances. It would then descend to the drying-rooms on the next floor, the hot chambers of which would be heated by gas; a part of this floor, however, would be open to the air. The next floor down would be the mangling, ironing, and sorting-rooms, and the linen would then pass to the delivery-room on the ground-floor for distribution. The machinery would all be worked by steam power.

The chapel, which would accommodate about 600, would be raised some few steps higher than the general level, for additional height and air, and light to the engine and pump rooms beneath, in which also the entrance to the well would be located which supplies the water.

DESIGN FOR A LIBRARY.

We give the perspective view and detail elevations, and plans of two floors to a small scale, of the design by Mr. Arthur Sykes, to which the Council of the Institute of Architects have awarded the Soane Medallion this year.

The Architectural Association. — The eighth ordinary meeting of this Association for the present session took place on the 1st inst., Mr. Herbert D. Appleton (President) in the chair. The following new members were elected, viz., Messrs. W. E. Pearman, W. J. Keith, A. M. Spencer, and H. E. Farmer. Mr. T. E. Pryce (Hon. Sec.) drew attention to the competition for the Painters' Company's prize, for which only two members of the Association might compete. The Chairman announced that the Birmingham Association had not yet passed their modified rules. He hoped, however, the matter of the affiliation would be brought forward at the next meeting. Mr. John Slater, B.A., next read a paper on "Artificial Illumination," which was illustrated by apparatus and experiments. We give the paper on another page.


Cambridge Street
Oxford Road
Footpath
St Pancras Gardens
Notes
Proposed New Buildings
Recent Buildings
Old Buildings
Scale 32 Feet to 1 Inch
Feet
Old St Pancras Church
Metropolitan Railway
Goods Station
Coal Drops
Coal Cellars
Coal Offices
Engine Shed
Engine Turntable
Goods Platform
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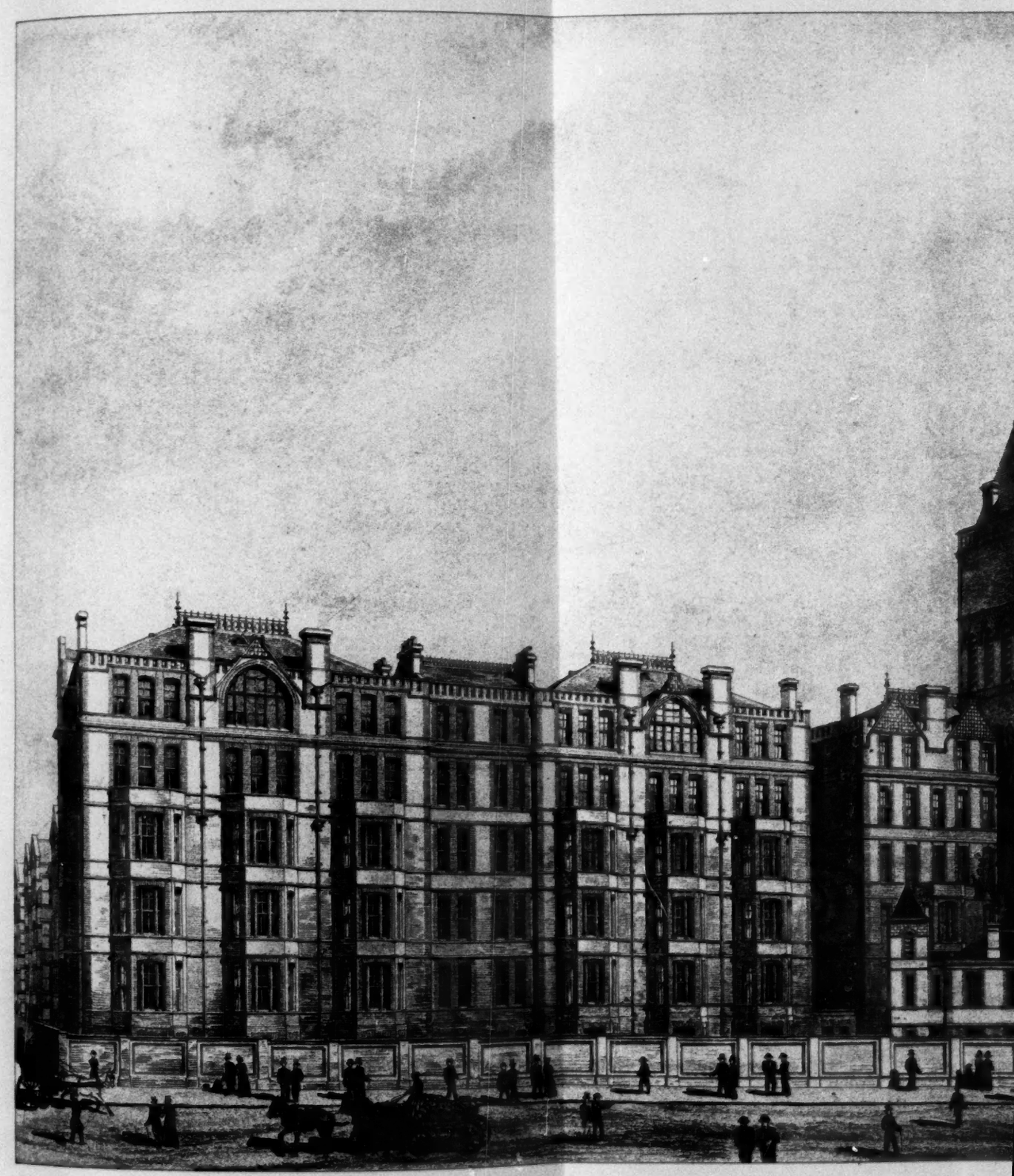

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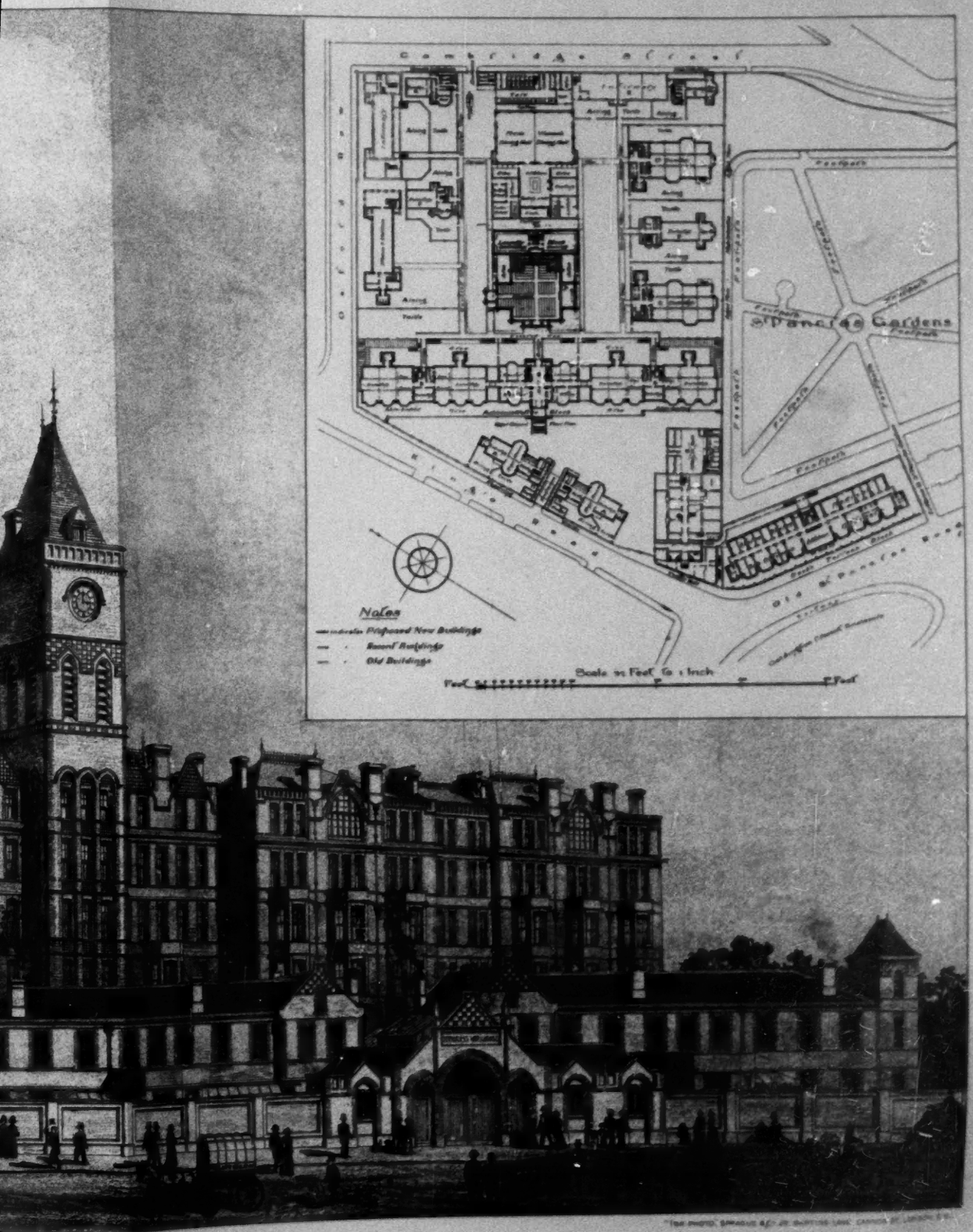
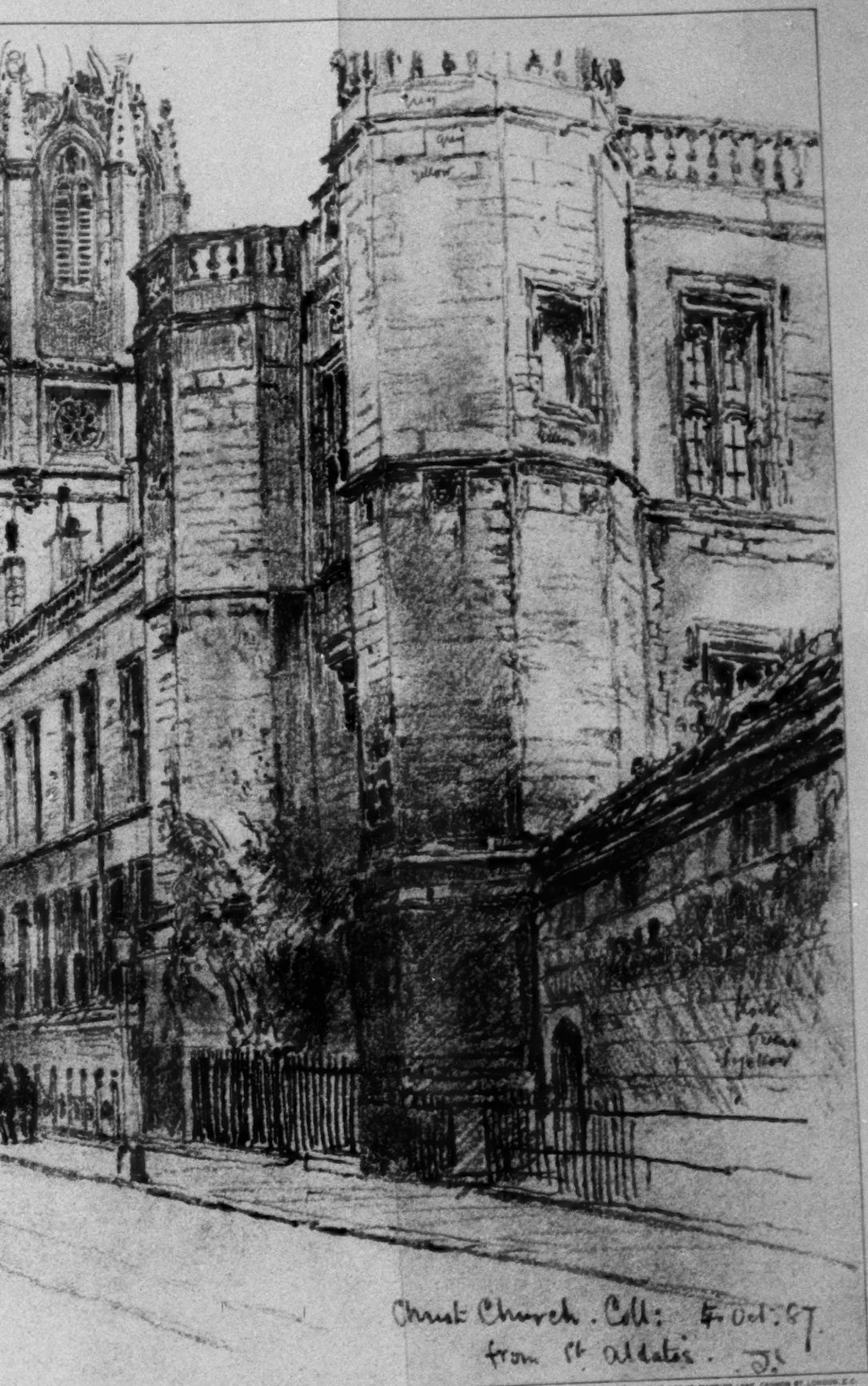


E.—Mr. H. H. Bridgman, F.R.I.B.A., Architect.

CHRIST CHURCH COLLEGE, OXFORD.—From a Drawing by Mr



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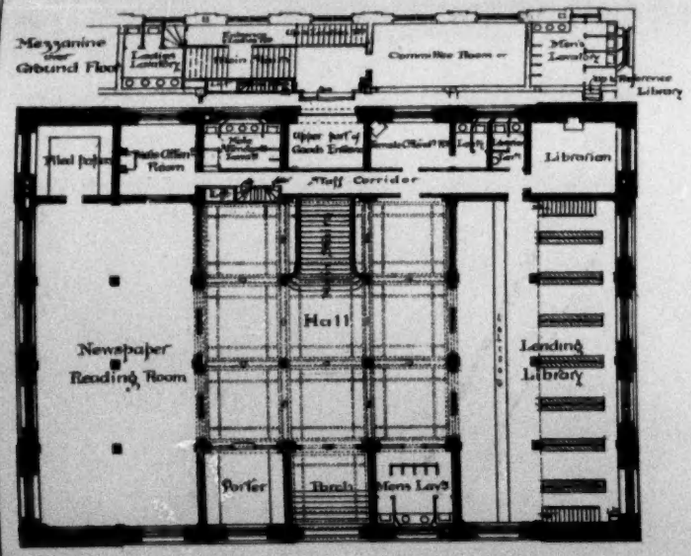

Plan of Ground Floor.

SCALE OF FEET

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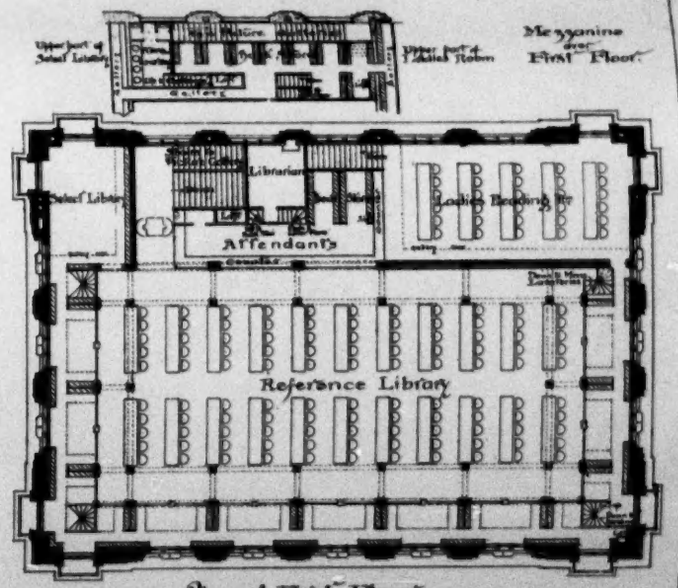
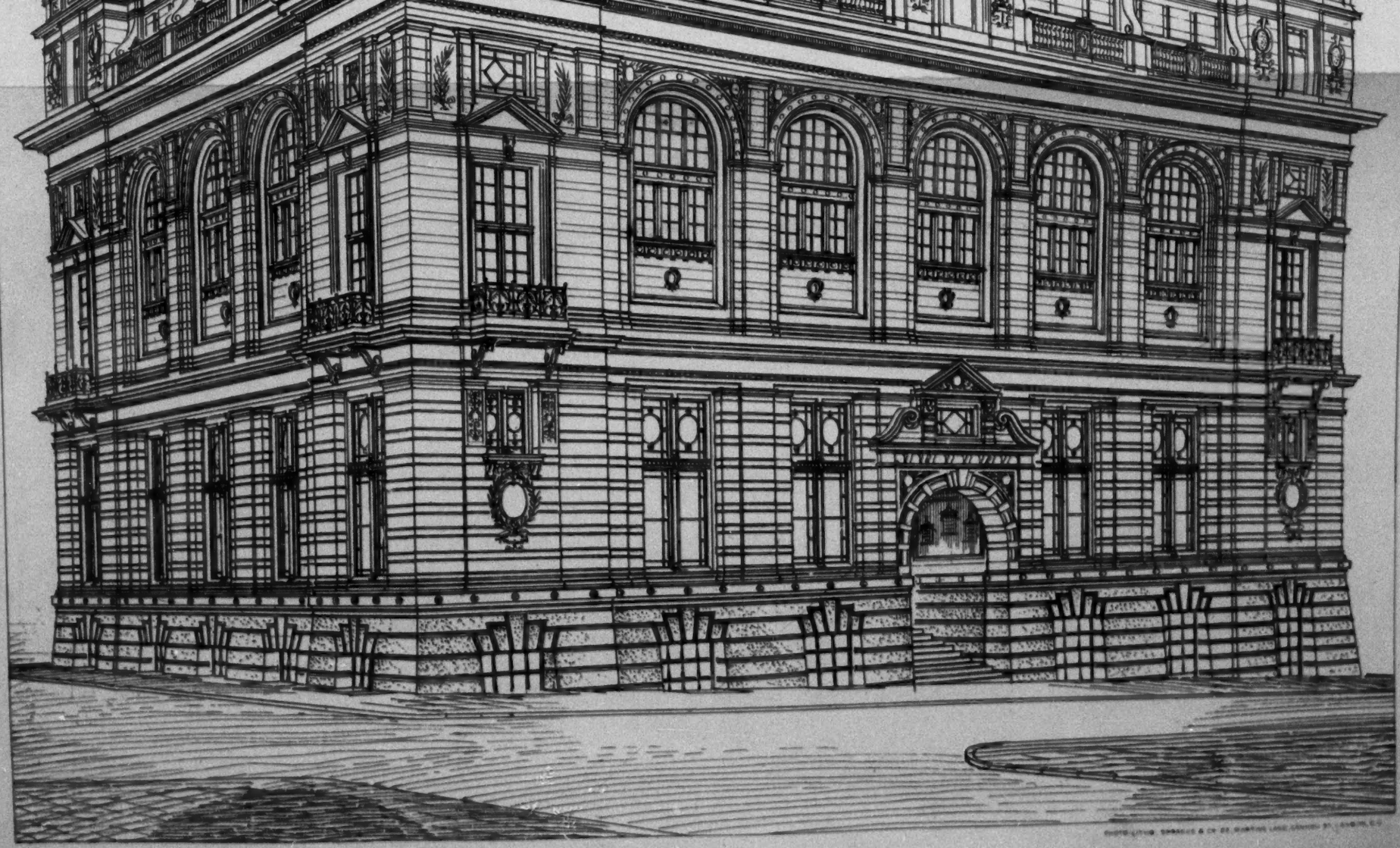


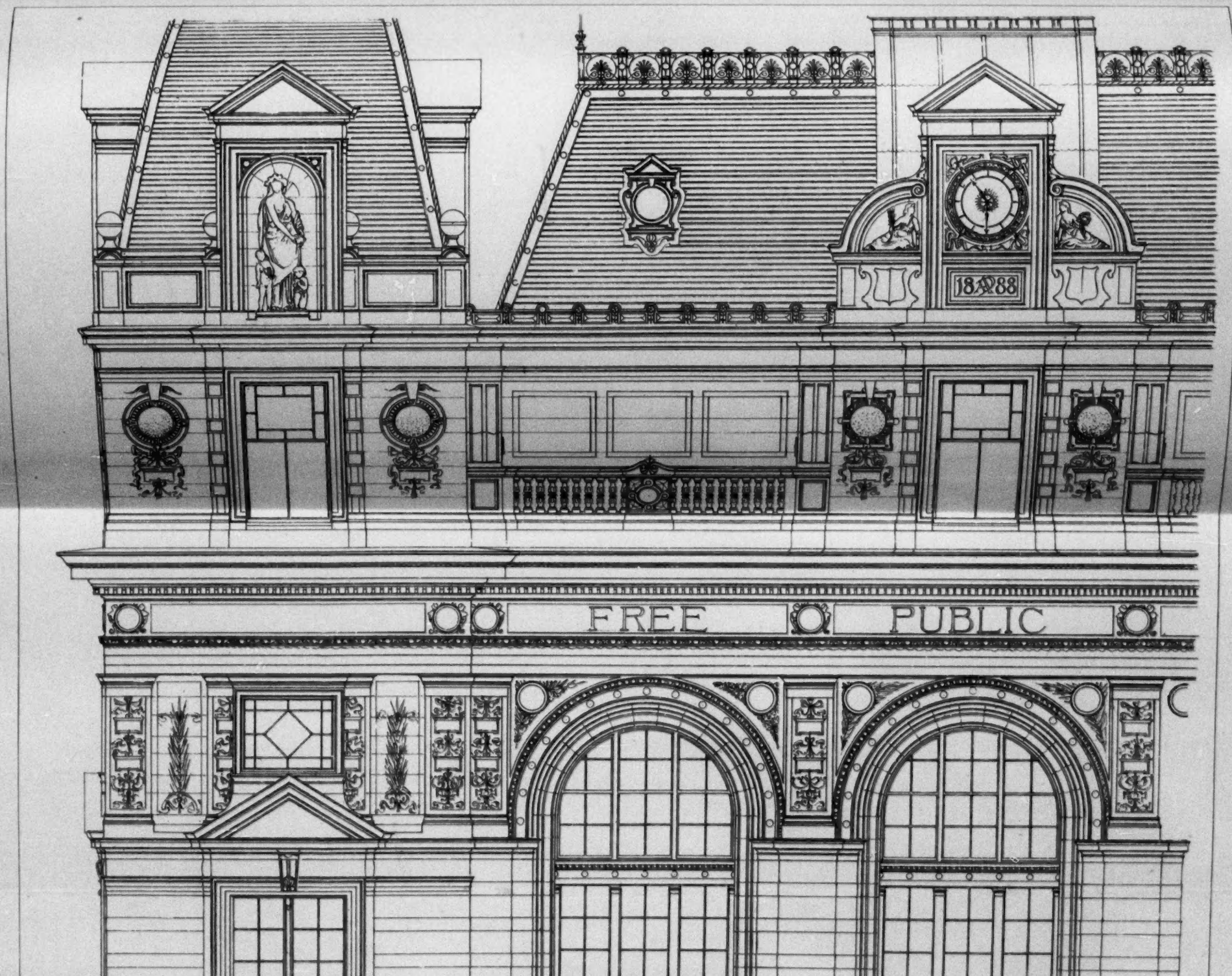
Plan of First Floor.



DESIGN FOR A PUBLIC LIBRARY.—By Mr. Arthur Sykes, A.R.I.B.A.,

PERSPECTIVE VIEW AND PLANS.

Awarded the Soane Medallion, R.I.B.A., 1889.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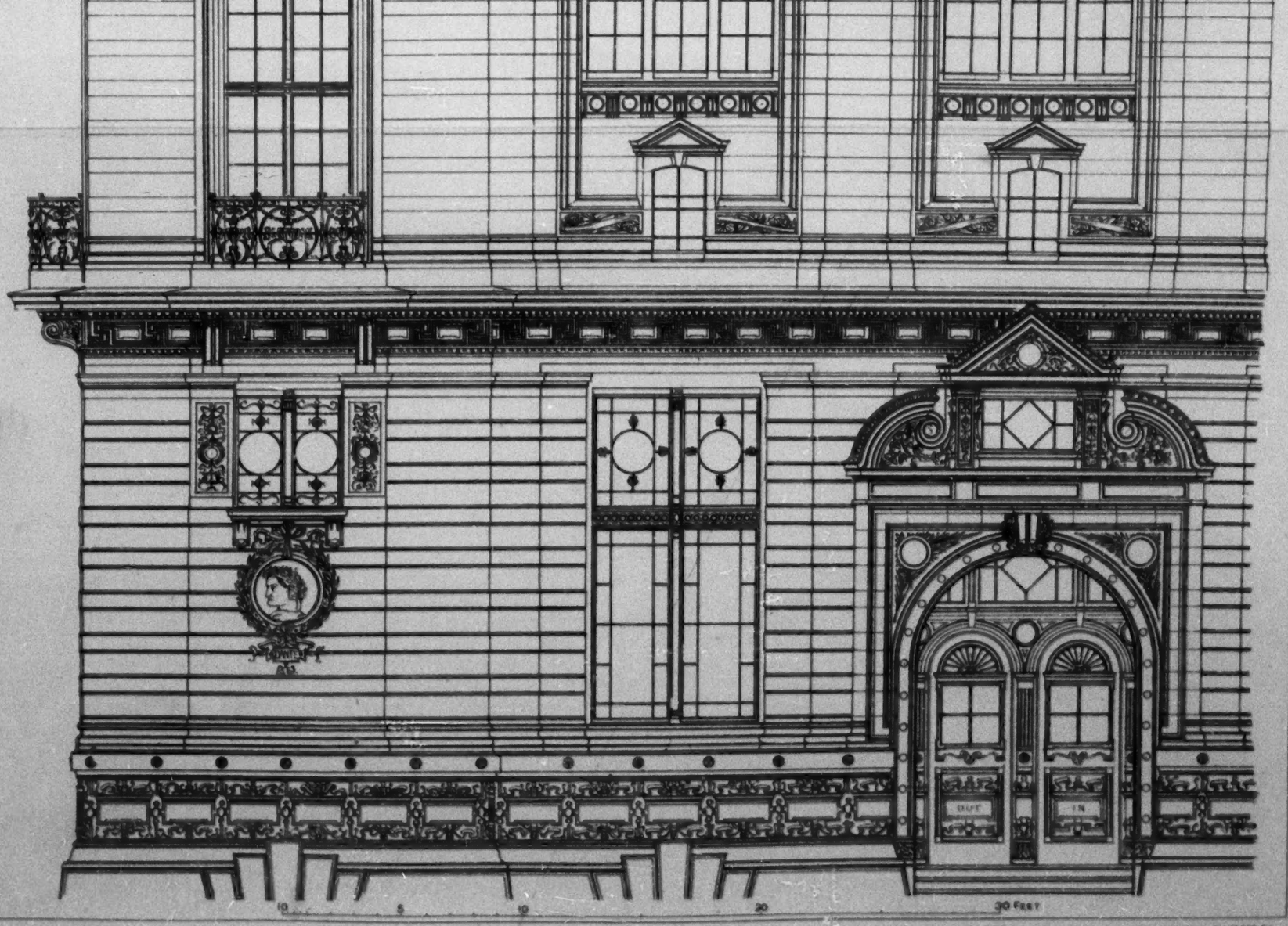


DESIGN FOR A PUBLIC LIBRARY.—By Mr. Arthur Sykes, A.R.I.B.A.

DETAIL ELEVATION.

Awarded the Soane Medallion, R.I.B.A., 1889.

CHAPTERS FROM THE HISTORY OF CARPENTRY AND JOINERY:

LECTURE AT CARPENTERS' HALL.

ON Wednesday evening last the first of the present series of free lectures at Carpenters' Hall on subjects connected with building was delivered by Professor T. Roger Smith, in lieu of the lecture announced by Mr. Banister Fletcher, who was unable to attend, having met with an accident.*

Professor Roger Smith said:—

The history of carpentry and joinery is one of the subjects on which questions are set in the technical examination which this Company holds annually, and, though a general historical account of carpentry and joinery in all ages and countries could no more be compressed into one lecture than the whole history of England, we may usefully examine together one or two detached chapters, as I have called them, confining ourselves chiefly to matters which can be illustrated by actual specimens accessible in or near London. It seems desirable, as we must make a selection, to direct our attention to examples where the worker in wood appears as an artist in preference to those where he is only a constructor, and where any example which has to be referred to makes a special appeal to our notice. I will endeavour to point out briefly what it is in the work that entitles it to rank as a work of art. Carpenters' and joiners' work, looked at as artistic, will demand our special attention in this Hall during the coming years, owing to the prizes which the liberality of Mr. Harben has placed at our disposal, and this circumstance has led me to take the line I have adopted.

When we try to satisfy our natural curiosity as to the works in wood executed by the great nations of antiquity who were famous builders, the fact that wood is perishable, and that fire or decay has swept all actual remains away, seems to shut the door in our faces; and yet we shall be able to find unmistakable indications of what was done by the carpenter in several historic nations, if we look for them. Before we do this, however, let me say a word about very ancient and primitive peoples, and the use they made of timber in building.

The first thing noticeable with regard to primitive folks is that men must be civilised enough to possess tools before they can make much use of timber. It is more possible for rude savages or uncivilised men to build themselves huts with stones and with earth than with timber, and the desirability of being able to work timber for various purposes has probably had a good deal to do with driving such people at an early stage to contrive axes and knives.

Savages unacquainted with the use of iron are, however, able, by the help of fire, and of stone and bone implements, to get down trees and make canoes. But probably the most ancient timber buildings,—those curious structures known as lake-dwellings,—were the work of persons further advanced than this. Lake-dwellings are found,—or rather remains and traces of them are found,—in various parts of the world, at the shallow margin of lakes, and in situations where it is fair to presume that the necessity for shaping timber into canoes or rafts had occasioned the people to acquire some dexterity in the felling and shaping of trees.

Lake-dwellings were built out right into the water, and are still in use in some countries. Near the shores of many lakes,—in Switzerland for example,—remains have been found of piles or strong stakes of timber driven in rows into the ground, and so disposed that it is clear they must have supported dwellings in which the ancient peoples had established themselves out in the lake, comparatively safe from marauders and wild beasts. Vast heaps of refuse which had accumulated round these ancient sites have been in some cases laid bare, where from circumstances the level of the lakes has fallen, and these mounds disclose many curious traces of the mode of life pursued by the ancient lake-dwellers. Probably these are the most ancient specimens of carpentry that survive in the world.

Those nations which advanced in civilisation and still employed timber would naturally come to make their timber buildings more and more highly finished as they improved. There can be no doubt that this was the case in many countries, though the buildings have long since perished; and when I use the words, there can be doubt I am not merely speaking in a speculative way about something that is very likely to have happened. I am dealing with things capable of proof, and the proof (which you will be the better able to enter into the more you know about carpentry) is this:—*They afterwards imitated their timber buildings in stone*, and the stone copies of originals which have perished have some of them come down to us.

The information which we gather in this way is not unlike that which the geologist can gather about some plants and animals,—such, for example, as many of those to be found in the coal. These plants have entirely decayed away and disappeared; but they have left an impression on the material which surrounded them, and we can see on the surface of the hard coal every frond of a fern perfectly imitated. Let us consider an example of somewhat the same nature where timber construction is imitated in stone in an anciently-settled European country.

If you will visit the British Museum, and, crossing the great Hall as if you were going to the reading-room, examine the large tomb from Lycia which you will find there, you will soon convince yourselves that this structure of stone is faithfully,—I might say slavishly,—imitated from a timber original. Let me try to point out the peculiarities which prove this.

The structure as we see it is not all ancient, as it will be seen that portions which were deficient have been supplied in stone of a different colour; but as far as the forms go, the new are faithfully copied from the old, and the shape is just that which this tomb had when it was erected new. Upon a rectangular base, which probably was of stone in the timber original, there comes a course of stone enriched with sculpture in relief, and upon this there appears, cut out in solid stone, what looks vastly like two plates of squared timber at the sides, with two corresponding plates at the end. The end-plates appear to be notched on to the side-plates, and the ends of the latter appear as though they projected slightly, while the ends of the former (the front and back plates) are longer,—are rounded,—and what is most remarkable, are notched. Above this comes a superstructure, the sides of which exhibit a series of projections half way up, and again at the top, resembling exactly the ends of timbers laid across at two levels, so as to form an intermediate support, permitting two coffins to lie one above the other in the interior of the timber original, forming a kind of ceiling above the top coffin. The end is divided into two by a kind of square pilaster, without cap or base, exactly like a wooden mullion, and in each half is a sinking exactly like a panel in a door.

The upper part has an arched outline, and there are imitation ribs, like those of a boat, and imitation timbers lying purlin-wise upon them, and overhanging; while the arched gable is again filled in with an imitation of panelling. Above the purlin-like timbers there are what are exactly like two thicknesses of boarding, and there is a heavy ridge to the roof, something like the keel of a boat.

No one of my audience who knows anything about masonry can for a moment feel that any one of the forms above the sculpture bears the least resemblance to anything that it would be natural to build in stone. No one with the least familiarity with carpentry, joinery, and boat-building can hesitate for a moment to recognise in every line the forms into which it is perfectly natural for the worker in wood to shape his material. Here, then, we have a timber structure imitated in stone. It is supposed to date about 600 years before the Christian era,—that is to say, about 2,400 years ago,—and, when you have examined it, you can say with certainty that at the time when it was originally put up the Lycians were accustomed to construct such tombs of timber, to square the beams, to halve them together much as carpenters do now, to enclose their tombs with panelled doors, and to roof them in a manner which reminds us that they, occupying a position on the shores of the Mediterranean Sea, were boat-builders as well as carpenters.

In Lycia, the country from which this specimen comes, a very considerable number of monuments remain, some of them cut in the face of the rock, and the greater part of them as similar to woodwork as the one I have described. In addition to these we, however, also find a certain number of monuments in which the forms proper to woodwork are abandoned, and forms only appropriate to masonry are used. These, without doubt, are of later date, and show us the transition from timber to stone completed.

From evidence of the same sort as that which I have put before you,—that is to say, from existing remains executed in stone, but imitating wood-work,—we are able to say that timber buildings were used by the Egyptians, the Assyrians, the Greeks, and other nations of antiquity, and we also know that timber roofs and floors were made use of by the ancients much in the same way in which we use them now.

I shall not attempt to detain you while I examine all the traces that occur in the finished work of the mason of the earlier use of carpentry in these countries. The most interesting topic which I should have to enlarge upon were I to do this would be the familiar forms of the Doric Order, as used by the Greeks. The triglyph is generally believed, and is expressly said by Vitruvius,—a Roman architect, who wrote a treatise on architecture,—to represent the end of a timber beam resting on another timber beam (the architrave), which the column carries, and most of the parts of the cornice look as if a timber original had given rise to them. The resemblance is not so undoubted as in the case of the Lycian tomb, but it is very marked, and, to my mind, there is no reasonable possibility of its not being recognised when pointed out.

Before leaving the nations of remote antiquity, I should like to direct your attention to a fragment of cabinet-maker's work which has lately been placed in the British Museum, and which may perhaps claim to be the oldest piece of such work now remaining. I allude to the chair of Queen Hatasou, which formed one of the most remarkable ojects in the great Manchester Exhibition two years back.

The Romans (who possessed the talent for construction in perfection) made use of both carpentry and joinery; but there are really fewer indications of how they carried out this work than is the case with the older nations to which I have alluded, for, of course, the actual specimens of work have perished, while no such imitations as have been found in Lycia, Egypt, and other countries were employed. Roman engineering and construction was founded upon the comparatively mature work of other and older nations. We know, however, that the Romans, in the early days of Rome, built timber bridges, for the first bridge over the River Tiber was of timber. The earlier theatres and amphitheatres were also made of wood, and it was considered an innovation, and looked upon with distrust, when the first theatre of a permanent character made of stone was erected in Rome. It is stated that the first amphitheatre was formed by erecting two theatres, each a semicircle, and set each on a pivot, so that the two could be placed back to back and used separately, or could be turned round face to face and used as an amphitheatre. It is obvious that if this was really done there must have been a great deal of constructive skill in the Roman carpenters, as it would not be an easy thing to form such a twin structure as this so that it would move at all, or so that when it was moved it should come together satisfactorily.

Both the Greeks and the Romans framed the roofs of their temples and other buildings in timber. They had gables or pediments and sloping roofs covered with tiles, the pitch of the roofs being the same as that of the pediments.

Joinery was but little employed in Roman buildings. They had in many cases curtains where we employ doors and windows. They had, as a rule, floors and skirtings of plaster or mosaic rather than, as is common with us, of wood, and they employed both bronze and marble for parts of their furniture. There is, however, visible at the British Museum a curious witness to the fact that the Romans sometimes used panelled doors like ours, in the shape of a door brought from the ruins of a Syrian town of Roman origin (now deserted), where stone was plentiful and wood scarce. This door is in stone, hinges and all, but resembles very closely in appearance a clumsy, square-panelled English door.

This closes what I may call my first chapter concerning ancient woodwork. The second, which can only be very fragmentary in its nature, has to do with woodwork in the East.

In Arabia, Persia, India, China, and Japan, we have vast nations all more or less highly civilised and given to building, and all con-

* We regret to learn that whilst Mr. Fletcher was riding on the 30th ult., his horse fell with him, dislocating his shoulder and injuring his ankle. He is at present confined to his house, but we are glad to hear that he is progressing favourably, and expects to be able to attend at his offices on Monday next.

nected together by such broad resemblances that we may speak of them, notwithstanding the differences of race and habits, in a general and comprehensive way as Orientals. Nearly all the important places of these countries enjoy a warmer climate than that of Europe, and this favours timber construction in more ways than one. The requirements of the people are sufficiently supplied by a comparatively slight structure. The absence of frost gives more prospect of such a structure proving durable. The climate encourages the growth of fine forest trees, of which the teak may be taken as a type. Accordingly, in most Oriental nations, timber architecture has been much used, and in one, at least, of them,—namely, Japan,—the liability to earthquakes has been a serious obstacle to the adoption of more permanent building materials. I am not, however, about to ask you to consider Oriental woodwork in much detail. It would require a lecturer more thoroughly at home in the subject than I can claim to be, a vast profusion of illustrations, and an evening to itself, to give you even an outline of such a subject. I can only pretend to put before you some detached facts of interest.

In India a great deal of beautiful woodwork has been executed, and is being done at the present day; and there the stone architecture, especially the Hindoo work, as distinguished from the Mohammedan, almost invariably betrays marks of the influence of timber forms, and in some cases is as completely a copy of them as the old Lycian tombs. Brackets and corbels, slender columns and projecting eaves, are constantly in use in stone buildings, the shapes of which, even when they are cut in stone, suggest timber as their original and proper material.

Fergusson, the best authority on the subject of Indian architecture, considered that in many parts of the country the timber originals existed, and, so to speak, set the fashion, very many centuries ago. In other districts temples and important buildings are still being built of timber; and in many parts of the country the fine timber obtainable is used for parts of domestic dwellings, and (as with us) for shop-fronts. Fortunately there exists within a few miles of this spot a collection of actual specimens of Indian domestic architecture, which will give you some little idea of what the leading forms are, and of the method of construction and ornamentation, and will illustrate to some extent this curious imitation of woodwork in stone which meets us at so many points, but nowhere more strikingly than in India.

As an example of Indian woodwork executed at a date before European influence had been at work on the taste of Indian artists, I wish to invite your attention to the architectural façade of a pair of street dwelling-houses built in Ahmedabad in the seventeenth century,—say, probably 250 years ago. The actual front of this block of buildings has been acquired for the South Kensington Museum, and brought to this country and rebuilt here, and is to be seen in the Indian department of the South Kensington collection, where I venture to hope some, at least, of my hearers will pay it a visit. These were a pair of comparatively small street houses, three stories high—*i.e.*, ground, first, and second floor,—and with a double verandah, or, in other words, two balconies, one above the other, running the entire length of both houses, at the level of the two upper floors; and the main architectural features are connected with these balconies, and are entirely in woodwork. The houses stand, as is very usual in the streets of Indian towns, on a kind of low basement or steep step of plastered masonry, about 2 ft. high and 2 ft. projection. The main wall of the building consists of two thicknesses of timber-framing of squared timber, about 2 ft. apart, with no attempt at ornament, and no part of it overhanging. The spaces are now filled with wood, but this represents, I believe, plastering on a kind of brick-nogging. The verandah at the level of the first floor is carried by six large brackets, and posts run up, one from each of these brackets, to the upper balcony, and other posts from that to the roof. The front is thus divided into five spaces or bays. These are unequal, three being narrow and two wide, symmetrically arrayed thus—narrow, wide, narrow, wide, narrow. Opposite each wide space there is a doorway in the wall behind on each floor, and opposite each narrow space a window. The brackets which support the lower balcony consist of a projecting timber built or pinned into the wall with a long raking strut to support the end of it. On this bracket rests a short block, and on that the plate carrying the front of the verandah. The floor of the verandah itself is carried by small joists, the ends of which show over the plate, and the soffits of which are also seen; and the balcony front, divided into large panels, is framed of stout timbers. The sturdy posts carrying the upper verandah, and the slighter ones going up to the roof, are polygonal, worked into a square at the top. They rise inside the verandah front, and are surmounted by brackets of different design from the heavy ones below, and of a general form very frequent in Indian buildings. The upper balcony front resembles the lower one, and the boldy-projecting roof above overshadows it and is carried on a system of timber brackets and plates resting on the posts already described, and is covered with tiles. The fronts of both balconies are not quite vertical, but lean a little outward.

Almost the whole of this woodwork is profusely covered with carving, in the best possible taste. The various brackets are boldly carved in very high relief. The panels of the balcony fronts, which are the most conspicuous surfaces, are filled with very delicate carving of leaves and flowers in various patterns; and the ends of the balcony joists, the various plates, the upper portions of the posts, and, in short, nearly every part of the woodwork, is also carved in low relief. Finally, all this carving has been painted in a very artistic and unobtrusive way, and a harmonious kind of rich golden tone is the result.

The carpentry is sensible, but roughly done, as far as one can examine it. The secret of the very great success of the work is, first, the appropriate design of the whole, and, secondly, the beauty of the carving and the colouring. Nothing can be more appropriate to the wants of a locality where they desire to overshadow the walls in the hot part of the day, and to be able to enjoy the breeze in the cool part, than this great verandah formed of two balconies; and with such a leading idea it would be hard to suggest anything more thoroughly successful and charming than this work of an unknown Indian artist, who died two centuries ago.

It is instructive to turn from the timber front I have described to a reproduction of the stone front of an Indian house which stands by its side. In that you see a verandah which, though executed in stone, is formed in imitation of timber. Slender shafts, overhanging roof, and corbels are among its most striking features. There are several other specimens of Indian woodwork in the same collection well worth examining for their carving, if not for their carpentry. There is one old example of a very elaborate timber balcony, brought from Lahore, and dating from the last century, to which I would especially direct attention, on account of the intricacy and beauty of the panels of pierced lattice-work with which much of the front is enclosed.

I believe you may take it that work much like these specimens was done in India at a much earlier date than that assigned to these Ahmedabad houses, and is still being done, but with the important difference that intercourse, first with the Portuguese and then with ourselves, has in many places modified the taste of the native artists and artificers, and has done them no good.

Before we pass on, it is worth while to notice some of the peculiarities of these Ahmedabad house-fronts, looked at as works of art. Nothing, in the first place, can be more appropriate. I have had the great good fortune to see India for a brief period, and I have felt what an Indian sun is like, and nothing seems so suitable as to surround the walls of your buildings with some sort of separate structure like these balconies, and to make the roofs overhang boldly, so that as much shadow as possible may be gained, and I am quite sure there is nothing that is more thoroughly essential to the artistic success of any constructed work than that it should seem fit,—fit for its purpose; fitly treated having regard to its materials, situation, the climate of the spot, and so forth; and fitly ornamented. If anything you build strikes the observer as unfit, you can never claim for it that it is a work of art. Another point is the blending of symmetry and variety in the spacing. Had all the bays been alike, the composition would have been comparatively tame and have lost part of its charm. Had they not been symmetrically handled, it would have looked irregular. Again, in looking it over from below to above, there is just that mixture of repetition and variety which is most conducive to grace. The great framed brackets, the stout posts of the lower balcony, the slender ones of the upper, keep up one line of support, but introduce variety, and the variety is still more interesting if you compare narrowly the things that are very nearly alike but not quite, such as one of the more sturdy posts below with one of the slenderer ones above, or one set of carved panels with another. The skill with which ornament is employed is quite as striking as the beauty of that ornament. This structure is first constructed and then decorated. You see all the timbers of the structure, and, though they are profusely carved, nothing interferes for a moment with the complete and clear display of the timber structure, of which, with the exception of a little that is hid by the balconies, the spectator takes in the whole at a glance. Then upon the parts which are not framing,—such as the panels, which are the proper field for decorative treatment, the artist has lavished his utmost resources, and the carving,—appropriate, varied, and harmoniously coloured,—is as rich as it well could be. These are some of the lessons which this bit of Indian work teaches us when we try to find out what it is that makes it pleasing, and they are lessons for us all. I should like to add, in conclusion, that several typical forms,—as it is usual to term those models which recur again and again under different modes of treatment, and yet, in spite of their difference, have a strong family likeness,—several typical forms I say, are to be found in the corbels and in the polygonal posts of this interesting structure.

While the reference to the South Kensington collection is fresh in your minds, I ought not to omit a mention of the specimens of Arabian work, of which several will be found close to the side entrance to the Museum, near the Science Schools. Here we have several balconies resembling the Indian work in having fronts plainly, if not rudely, framed together in wood-work, but with the peculiarity that the panels are filled by grilles or lattices formed of small pieces of wood turned and moulded, not bigger than large cotton reels, and fixed together so as to form out of the most simple materials, the most rich and pleasing designs. Most of the work in Arab architecture is done in materials not at present under our notice, but these balconies are too characteristic and too good to be passed over.

In China, carpenter's work is employed both in private houses and in some larger structures and pagodas. The roofs of these have a tolerably sharp pitch, with boldly overhanging eaves, very much tilted up, and the angle so formed eased off to a curve, which makes a characteristic outline. The hips of these roofs are made very prominent and ornamented.

"Another peculiarity," says Fergusson, "is their mode of framing a roof, so unlike that of any other people. This arises from the timber most easily available for the purpose being a small pine, which has the peculiarity of being soft and spongy inside, while the outer rims of wood just under the bark retain their hardness and strength. It is thus practically a hollow wooden cylinder, which, if squared to form a framing as we do, would fall to pieces, but, merely cleaned and used whole, it is a very strong and durable building-material, though one which requires all a Chinaman's ingenuity and neatness to frame together with sufficient rigidity for the purposes of a roof. The uprights which support these roofs are generally formed of the same wood, though not unfrequently they are granite posts,—they cannot be called pillars,—of the same dimensions, and strengthened, or rather steadied, by transverse pieces of wood, the space between which and the roof is generally filled with open-work carving, so as to form a species of frieze. The roof is usually constructed by using three or four transverse pieces or tie-beams one above the other, the ends of each beam being supported on that below it by means of a framed piece of a different class of wood. By this method, though it may look unscientific, they make up a framing that resists the strongest winds uninjured."

Japan, as has already been hinted, affords a remarkable example of the almost universal employment of timber for buildings. A complete account of this system of construction may be found in the papers by Professor Josiah Conder, read before the Royal Institute of British Architects, and, seeing the impossibility of giving a sufficient account in this lecture, I

cannot do better than refer those who are anxious to investigate Japanese timber-building to those exhaustive papers."*

FAIRFORD CHURCH WINDOWS.

SIR, — My attention has been called to a paragraph in the *Builder* of January 26, commenting on my letter which appeared in the *Times* of January 19. I should like to have the opportunity of re-assuring any lovers of ancient art who may bear with some misgiving of the "restoration" of Fairford Windows, that *no such work is contemplated*. Where portions of a light or pieces of glass are upside down, or otherwise obviously out of place, they will be put back in their original positions. The Prophets in the windows of the north aisle will also, I hope, be placed in their original order, so as to correspond with the series of Apostles on the opposite side of the church. The windows were removed from the church in the seventeenth century to save them from the hands of iconoclasts, and when they were replaced, the order of the Prophets was changed, as Mr. Joyce has pointed out in his splendid monograph.

Except in the particulars here given, it is not proposed to make any alteration in the windows as they now stand. Where pieces are unfortunately missing, no attempt will be made to replace them; and I think the public may safely trust Mr. Westlake to insert in the vacant places glass of such a tone as to disfigure the windows as little as possible. The lines of the old (in many lights the original) leading will, of course, be closely followed, and, as far as our funds will allow, everything will be done to preserve these marvellous relics of a lost art in all their beauty.

You very properly remind me, Sir, that I am the trustee of a public fund, and that it would be well that I should state what has been collected, and how the money has been spent. The Rev. A. S. Loxley, late Vicar of Fairford, appealed to the people of this neighbourhood and county to assist him in raising 2,000*l.* to restore the roof, and 1,000*l.* to preserve the windows of Fairford Church; but he found that the subscriptions were not sufficient to justify him in commencing the work. Deducting the expenses of printing and postage, the amount collected by Mr. Loxley was 466*l.* 13s. 3d., and he received promises of some 300*l.* more. I have already published in the *Times* a list of all the subscriptions over 5*l.* paid or promised, whether to my predecessor or myself. The sum now in hand and available for the entire work (roof and windows) is 686*l.* 10s. 6d. In addition there is the grant of the Warneford trustees, 500*l.*, and other promises, 338*l.*; total, 1,524*l.* 10s. 6d.

Of this sum 139*l.* has been paid, or promised definitely, for the windows; 500*l.* (the Warneford grant) for the roof and fabric; and the remainder for the general work of restoration. The Committee hope to begin next May the restoration of the nave roof and the releading of the clearstory windows. They will carry on the work as far as the funds at their disposal will allow; possibly (if further subscriptions come in), they may be able to undertake the south aisle and windows also this year. The whole work will be carried out in the most conservative spirit, under the direction of Mr. Waller and Mr. Westlake. I hope, Sir, that I have now given full particulars. Allow me to add that I shall be at all times happy to furnish you with any information as to our doings here which you think may be of interest to your readers.

FRANCIS R. CARDONELL.

Fairford Vicarage, Feb. 2.

DRY-ROT AND SAWDUST.

SIR,—As it is a very common provision in many architects' specifications that dry sawdust be used as filling in framed partitions, and between flooring and sound-boarding, for the purpose of deadening sound, I wish to call attention to the risk thus run of communicating dry-rot to the surrounding timber. The sawdust contains particles of timber of all kinds,—good, bad, and indifferent,—outside slabs (covered with vegetable and decaying matter), and rotten hearts. Now, are not the chances of dry-rot thus increased one thousand-fold by this sawdust, as each or any of its particles may contain the germs of the fungus, which require only a sufficient amount of damp to spring forth and lay hold of the otherwise sound timbers around, whatever they may be. I have had over twenty-five years' experience in building, and firmly believe that this sawdust filling is a most fertile source of dry-rot, and I consider the matter well worthy the careful consideration of architects, to whose attention I would bring it through your widely-read columns.

CLERK OF WORKS.

*** We have not come across any cases in which dry-rot has been traced to sawdust filling; but, of course, it is understood (and should be always specified) that sawdust so used should be "stove-dried," and if heated to the highest temperature it will bear without burning, we should doubt if any spores of dry-rot or other disease could be left in a state to fructify. Without any stove-drying, of course, the danger noted by our correspondent would be a very real one. We should, however, recommend slag-wool in preference to sawdust.—ED.

* To be continued.

RED ANTS.

SIR,—I shall be glad if any of your numerous readers could tell me the best means of ridding one of my houses at the seaside of small red ants, which completely overrun it.

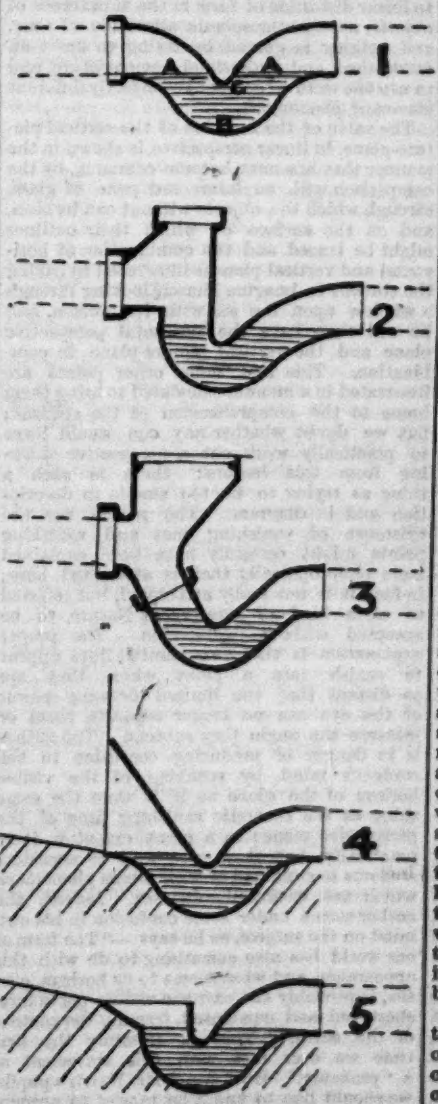
BUILDER.

The Student's Column.

TOWN DRAINAGE.

VI.—TRAPS.

A TRAP is a thing for preventing the flow of air through a pipe in one direction, while offering as little obstruction as possible to the flow of sewage in the opposite direction. Traps are placed in various situations, each of which requires a suitable form, as, for instance, on a line of drain, in which case the trap forms part of the drain, and through which the sewage flows continuously in the same line, as in figure 1. In some situations the continuity of the line of drain is required to be broken by a vertical shaft or chamber, for various purposes, as for access to the trap, or for admitting air to the drain, or for receiving a branch into the main drain. The trap is then placed on the lower side of the opening. Traps suitable for this situation are shown in figures



2, 3, 4, and 5. In other situations sewage may be required to enter the trap vertically and leave it horizontally, or with any slight fall which may be given to the drain; or it may enter the trap vertically and leave it at any downward angle, and in some situations it both enters and leaves the trap vertically.

In all these traps the essential part is the same,—viz., the part shaded in the figures. The form of this part, or the throat of the trap, should be such as to offer the least obstruction to the passage of sewage. It is commonly made circular in cross section, of the same diameter as the straight pipes of the drain, and is so drawn in the figures; but it is not the best form for all the situations named above, although it is so for the first one. It will be sufficient, however, at present to keep to the more common form in this respect.

A trap on a line of drain, which forms a part of the drain, and through which the sewage flows in a continuous stream, or should do so, consists of a dip of the top of the pipe at one point below the bottom of the pipe in the adjoining part, as in fig. 1. The point C is 2 in. lower than the bottom of the drain A. The sewage lies dead in the trap below the level A, when no sewage is running in the drain. The diameter of the trap in its throat being the same as that of the drain—say 6 in.—the bottom of the trap is 8 in. lower than the bottom of the drain. The point C is sometimes attempted to be made 3 in. below the bottom of the drain, but this only increases the difficulty, and 2 in. is more usual. Less than this would be better, were it not that it is necessary to guard against the water level being reduced by evaporation below the point C. In a dry state of the atmosphere, and a long disuse of the drain, this happens, and a dip of 2 in. is little enough.

The quantity of sewage issuing from a house at any one time is in general but small, and is seldom sufficient to cause much disturbance of the dead sewage in the trap, and consequently sediment forms in the bottom. In course of time this reaches nearly to the top, C, and contracts the waterway, so that the velocity of even a small quantity of sewage passing along the drain is sufficient—if the dip be not too great—to clear a passage for itself, carrying with it from the trap as much of the old sediment, perhaps, as the new which it brings into the trap. The longer the time during which sediment is being formed before it chokes the trap, the harder it becomes, and the more difficult to move, and in course of time it all becomes solid and stops the flow of sewage,—or may do so in any case, and actually does in many. The trap must therefore be accessible from the surface of the ground.

The forms of traps shown in the accompanying sketches are elementary, drawn chiefly for the purpose of noticing the various directions and changes of direction in which sewage is required to flow under various circumstances, and for directing attention to the one principle on which they are all formed, viz., that a head of water an inch or two in height is opposed to the passage of air through the pipe. When the expansive force of the air is the same on both sides of the trap the water surface remains level, but if it be much greater on one side than the other this head of water will be overcome and the air will pass through the trap, its water being temporarily displaced by pressure on the one side only, returning again, however, into the trap after the excess of pressure on the other side has been relieved by the escape of the air of greater pressure; so that if drains are placed under circumstances which make it possible that a greater pressure of air may take place on one side of a trap than on the other,—whether by reason of the expansion caused by heat, or by an accumulation of gas generated in the drain or in a sewer with which it is connected, and which has no easier means of relieving its excessive tension than through the water-trap,—if this become possible the action indicated will take place without its being known whether it has done so or not by any inspection of the trap afterwards which may be made, for the water will be found to have returned to the trap. If air escape in this way through a trap it may become known, certainly, by its effects, but only, perhaps, when too late.

Supposing an extreme abstract case, where the common pressure of the atmosphere exists on one side of a barrier and a vacuum on the other. There would then be a pressure upon it of 14·7 lb. per square in. when mercury stands 30 in. high in a barometer. In that case it would require a column of water on the opposite side 34 ft. high to balance the pressure of the atmosphere on the other side, and the same head of water would be required if the expansive force of the air were doubled on one side of the barrier, that is if it become 29·4 lb. per square in., the ordinary pressure of the atmosphere, or 14·7 lb., being on the other side, and

the same in proportion for any actual difference of pressure, however small; and, to come to a practical case, if the expansive force of the air on one side of a trap be increased by one two-hundredth part ($\frac{1}{200}$) it would remove the water from its own side of a dip 2 in. in depth which might be given to the trap, as in the sketches; and if the trap be so placed that the water on the other or far side of the trap—always looking up the drain—would begin to spread out, or run back up the drain, at the level of the standing water in the trap, this $\frac{1}{200}$ increase of pressure, which would be to increase it from 14·7 to 14·77 lb. per square in., would be sufficient to enable the air pass through the trap.

But if, on the far side of the trap, the water be confined so that it must rise before it can spread out, its weight must be first lifted by the expansive air before the trap can be unsealed. Suppose the trap be made so that the water must rise in this way to a height of 3 in. before it begins to run back up the drain, or escape in any other way, the pressure of the air on the other side of the trap will not overcome the weight of this water until the excess of pressure has increased by $\frac{1}{10}$ more than that of the atmosphere, or an increase from 14·7 to 14·88 lb. per square inch. It will then begin to blow through. Suppose the maker of a trap should say 3 in. is not enough, and should make his own traps with a height of 6 in. in this particular part, thus opposing a head of water 6 in. in height against any pressure of air from the other side: the water would then have to rise 6 in. before it could begin to spread out or run away from the trap: the head would be 8 in., adding the 2 in. dip to the 6 in. head above the standing water level, and it would begin to run back up the drain when the pressure of the air on the other side of the trap might be increased by $\frac{1}{10}$ more than the common pressure of the atmosphere, or to 15 lb. per square inch. This drop of 6 in. is the greatest of any trap made. Some have none, some 2 in., some 3 in., and so on up to 6 in. But we do not mean to say the greater the better. Whatever the drop may be it takes so much away from the fall of the drain, reducing its rate of inclination in the other parts.

As to the difference of pressure on the two sides of a trap there is a great deal of uncertainty as to its actual amount in drains and sewers. Few persons take the trouble, or have the opportunity, to make observations sufficiently numerous and extending over a sufficient length of time,—say hourly for twelve months, at least,—to establish anything which can be relied upon. The question concerns the Sanitary Committees of Corporations and Local Boards more than anybody else. They have the means, and if they had the inclination to order a series of observations to be made for their own information and guidance, so as to be able to speak authoritatively in their own town on this matter, it would be a very serviceable thing to themselves and to the people they represent.

But it is certain that a very small increase of temperature increases the elastic force of confined air in a degree quite sufficient to force it through a trap having 5 in. or 8 in. head of water, or even more. There may be an easier means of its escape than that of passing through the trap; it may, for instance, escape into the street through open gratings if they be not too far away. But, supposing the open gratings near the drain in which the increased pressure takes place to be stopped, as they sometimes are, by order of persons or committees who ought to know better, but do not, then, instead of this air, which is being increased in pressure by the discharge of hot water into the drain, or which becomes of greater temperature by any other means, travelling along a sewer until it finds an open grating, or becoming sufficiently diffused in the sewers to lose its excessive pressure, it will, rather than encounter the obstruction to its flow through the sewer to any great distance, find its easiest way of escape through a trap, which may be placed for the express purpose of stopping it, if that trap do not oppose more than the ordinary head of water to it; for, supposing this confined air to be of the ordinary temperature of 60 deg. Fahr., and to have the common expansive force of 14·7 lb. per square inch, it needs only that its temperature be raised 10 deg. or to 70 deg. Fahr., to overcome a head of water of 8 in.; 66⅔ deg. Fahr. to overcome 5 in.; and only 62½ deg. to remove the 2 in. depth of water formed by the ordinary dip of the trap shown in the diagrams.

Books.

The Theory of Perspective. Two Lectures. By Frederick Harris. (London: Relfe Bros.)

The author of this little work, who is head-master of the Chesterfield Central Stafford Municipal Schools of Art, appears to have been endeavouring to give the practical meaning of perspective in as simple and natural a manner as possible, with little technical language, and only three or four small diagrams. He does not use the expression "theory of perspective" as usually understood, for his first chapter is mainly taken up with the appearances of things as affected by distance and atmospheric conditions; what is usually called "aërial perspective." The remarks on this part of the subject are true and practical enough, and tend to impress on the learner's mind the fact that, in all drawing and colouring from nature, it is with appearances as modified by circumstances that he has to deal, and not with literal facts. This, however, is a matter of ordinary perception and observation, while the theory of perspective, properly so called, is a matter of scientific geometrical demonstration, and therefore to class these two subjects together under the general term "The Theory of Perspective," is rather apt to confuse the mind of the student between two classes of facts which are essentially different. The author may argue that "perspective" signifies the representation of nature as seen, and, therefore, should include atmospheric effect; but, as a matter of fact, the word "perspective" has always been applied and understood as referring to linear distortion of form in the appearance of objects, not to atmospheric alteration of tone, and nothing is gained by trying to upset an established and understood nomenclature, and to use one word to define two perfectly different classes of phenomena.

The value of the function of the vertical picture-plane, in linear perspective, is shown in the manner that has now become common, by the comparison with an interposed pane of glass, through which the objects without can be seen, and on the surface of which their outlines might be traced, and the combination of horizontal and vertical plane is illustrated by asking the student to imagine himself looking through a window upon the sea with its horizon, and he will then have the horizontal perspective plane and the vertical picture-plane in combination. This and some other points are illustrated in a manner calculated to bring them home to the comprehension of the student; but we doubt whether any one would learn to practically work out a perspective drawing from this lecture: there is such a thing as trying to be too simple in description and in diagram. The reason for the existence of vanishing lines and vanishing points might certainly have been explained more philosophically than is attempted here; in fact, it is not really attempted, but referred to as a kind of mystery of Nature, to be accepted without explanation. The proper explanation is that two parallel lines appear to vanish into a point when they are so distant that the limited defining power of the eye can no longer separate them or measure the angle they subtend. The author is in danger of producing confusion in the student's mind by speaking of the visible horizon of the globe as if it were the same thing as the theoretic vanishing line of the perspective plane; to a great extent it is so practically, but it is not well to accustom students to confound in their minds phenomena which are essentially distinct. Indeed, the author seems under some confusion in his own mind on the subject, as he says:—"The form of our world has also something to do with this appearance, and what seems to us horizon, over sea, is probably the extreme visible curve foreshortened and condensed, forming the contour of the earth." That is certainly the first time we ever met with this statement as a "probably." How would Mr. Harris's pupils, we should like to know, be taught to account for the fact that after a ship is "hull down," and, therefore, beyond the visible horizon, her sails can still be seen subtending an easily measurable angle to the eye? However, the author is, we gather, a "departmental" art teacher (the book is intended for the use of students preparing for the second-grade examination), and this is not the first time we have found evidence that departmental masters are apt to be somewhat illogical in their theories of perspective.

St. Martin's-on-the-Hill, Scarborough, and its late Vicar, the Rev. R. H. Parr. By the Rev. Newton Mant, B.A. Cantab. (London: Simpkin, Marshall, & Co. (Scarborough: E. T. W. Dennis.)

This little work, the major portion of which is reprinted from the *Church Times* and the *Yorkshire Weekly Post*, is written in memory of the late Vicar, who will long be remembered in Scarborough as the founder of a remarkable church and the centre of a large and earnest congregation. The church, which was consecrated in 1863, is a prominent feature on the heights above the town, and has a befitting individuality. It was designed by Mr. Bodley, and added to in 1879 by Messrs. Bodley & Garner. The adornment of the interior has employed some of the foremost artists of the day—Burne Jones, Ford Madox Brown, William Morris, Spencer Stanhope, and others.

Mr. Aston Webb has drawn, so says the Rev. historian, the cartoons for the stained glass, and has decorated, in company with Burne Jones, the chancel roof. In the short biographical notice which, in common with the other eminent artists employed, Mr. Aston Webb is favoured with, it is admitted that his work has been "mainly architectural," and although we are prepared to believe anything as to Mr. Aston Webb's skill as an artist, we cannot help thinking that some mistake has here crept into the otherwise veracious narrative.

The book is neatly presented (although the illustrations of the church are far below its merits), and will, no doubt, find a hearty welcome amongst the late Vicar's parishioners and admirers.

Walks in the Ardennes. Cycling, Driving, Boating, by Rail, and on Foot. With some fishing and shooting notes. Edited by Percy Lindley. Pen-and-ink sketches by J. F. Weedon. (Published at 125, Fleet-street, London.)

The real originators of this book are probably the Great Eastern Railway Company, who naturally desire to bring before the touring public the attractions of the districts to which their lines of railway and steamships give the readiest access. They have entrusted the work to capable hands, and the result is a pleasant little book of sixty-seven pages, well written and well illustrated, and sold at a merely nominal sum. An excellent route-map affords the basis of a description of suitable walks in the "Forest of Arden," which must be seen soon if at all, for it is suffering the usual fate of districts which are advertised, and is fast losing much of what made it attractive. The tramway is superseding the diligence, and a decrease of picturesqueness and an increase in the cost of everything are supervening. However, there is yet time, and the tourist who is forecasting his next autumn's holiday will do well to bend his steps towards the Ardennes, and cannot do better than slip into a spare pocket this light, thin, handy, chatty, genial guide.

The English Iron Trade.—The English iron market is strong, and is getting more active than it was at the beginning of the year. Besides the rising tendency manifested in finished iron and steel, to which reference was made last week, pig-iron is experiencing a slightly upward movement. The Glasgow warrant market has somewhat improved, while the north-country pig-iron trade is better, the favourable nature of the ironmasters' returns of stocks having had a stimulating effect. Inquiry in Lancashire is fairly well sustained, and prices are steady. The Staffordshire pig-iron market is firm. Hematites are quoted 6d. a ton higher this week in the north-west, there being an improvement in the demand, which has enabled makers to be stiffer in their prices. Spiegeleisen has advanced 2s. 6d. a ton. Manufactured iron continues fairly active. Tin-plates are quiet, but steady. The steel trade has received a further impulse this week, and prices are rising. Rails have gone up 5s. a ton in the north-west, and 2s. 6d. in the north of England, the demand being very brisk. Blooms and slabs have gained 1s. 6d. a ton. There is a very heavy consumption of shipbuilding steel, without any further improvement in value, however. Shipbuilders are still receiving additional orders. Some engineers have more work offered them than they can undertake.—*Iron.*

RECENT PATENTS.

ABSTRACTS OF SPECIFICATIONS.

2,605, Cooling, Ventilating, &c. E. Dean.

For cooling buildings and apartments in hot countries without excluding the light, glass louvres or slats are, according to this invention, used. These are mounted on frames or screens. On the framing of the screen is fixed a perforated water-pipe, so that water is sprayed on to the louvres. These louvres may be covered with fabric or stained, if it is desired to subdue the light.

3,178, Partitions for Dividing Rooms. T. Cook.

Revolving sliding partitions, glazed or decorated, are proposed to be used by this inventor. Each leaf of the partition is hung at the top, and furnished with a swivel, a pulley, and rail, by which the partition leaves are moved against the side walls of the room. The partition, when in use, is bolted to the floor, a wood slip keeping them straight in line.

3,513, Dressing, Grinding, or Cutting Stone. W. Rigby.

According to this invention, a travelling-frame is used, on which the slab of stone to be operated upon is placed. Above this rollers or grinders are placed, of a shape the converse of the moulding desired to be cut on the stone. A weight causes the travelling-frame, with the stone upon it, to be drawn under, and in contact with the grinder.

3,641, Cellar Gratings. G. Humphrey.

The grating which is the subject of this invention is formed of cross-bars, and immediately underneath is another similar frame. A small socket and slot are fixed in the centre, so that when one is pushed behind or below the other, after the manner of sliding ventilators, the openings are closed or opened as desired.

17,554, Furniture Polish. M. A. Harrach.

In order to avoid the use of oil, and instead of using ether as a solvent in making up the polish, spermaceti, palmitine, stearine, or some such compound is used by this inventor.

17,681, Fire-escape. C. Brawn.

According to this invention, flat rope or web is used, and passed through a plate perforated with small slits or holes. These regulate the sliding of the rope through the plate. A webbing sling is provided, and when the weight comes on the appliance, a descent is easily and safely made, the speed being regulated by the person holding the rope drawing it tighter or letting it run freer as desired. The rope has an eye at either end, so that after the descent is made the little appliance is pulled up from below, and is again ready for operation.

NEW APPLICATIONS FOR PATENTS.

Jan. 21.—1,071, J. Wilkie, Builders' Cramps.—1,086, C. Brawn, Appliance for Cleaning or Repairing Windows.

Jan. 22.—1,120, B. Smith and F. Taylor, Tile and Gutter for Roofing, &c.—1,138, J. Keeler, Hinge for Step-ladders.—1,158, W. Woodward and J. Walton, Lock or Lock-fastening for Doors.

Jan. 23.—1,221, M. Adams, Gully Traps.—1,224, J. Milne, Flushing Apparatus for Water-closet Cisterns, &c.—1,240, E. Cory and others, Motive Power Mortising Machines.—1,262, A. McLean, Artificial Stone.—1,268, W. Lorenz, Straight and Circular Saws, &c.

Jan. 24.—1,281, A. Hewson and S. Bradley, Window-sash and Casement Fastener.—1,282, J. Hannay, White Lead, &c.—1,300, O. Christie and F. Mason, Draught-preventer.—1,312, J. Barrow, Chimney-tops.—1,332, J. Read, Bakers' Ovens.—1,346, J. Hall, White Lead.

Jan. 25.—1,363, J. Clayton and C. Tindall, Water-closets.—1,386, F. Rosentreter and W. Caldwell, Sash-balance.—1,403, J. Clarke, Revolving Window-frames.—1,415, E. Maldant, Watermeter.—1,422, T. Oakley and E. Smith, Ventilation of Buildings, &c.

Jan. 26.—1,435, A. Fowler, Privies and Water-closets.

PROVISIONAL SPECIFICATIONS ACCEPTED.

14,596, R. McKeeman and S. Pillar, Raising Water-closet Seats.—16,670, M. Chanlin, Locks and Latches.—17,823, J. Carter, Water-closets.—17,839, J. Cole, Ventilating Sash-fasteners.—17,885, W. Lark, Plumb Rule.—18,160, R. Barr, Self-locking Safety Latch.—18,244, A. Martyn, Decorative Panels, &c.—18,451, E. and J. Brook, Kilns.—18,491, W. Joy, Preparation of Slurry for Cement, &c.—18,637, G. Jones, Water-closets, &c.—19,038, F. Baker, Door Curtain Rods.—19,064, T. Cantwell and R. Randell, Flooring.—25, R. Hepburn, Sign Letters, &c.—63, O. Earl, Outside Shop Fittings.—234, A. Illidge, Opening and Closing Fanlights, &c.—495, F. Carter and others, Combination Nail and Screw.

COMPLETE SPECIFICATIONS ACCEPTED.

Open to Opposition for Two Months.

1,515, C. Eisner, Machines for Cutting Clay for Bricks, Tiles, &c.—3,560, J. Kaye, Handles for Doors and Locks.—4,413, B. Lee and T. Neale, Producing a Marbled or Grained Enamelled Surface on Cast Iron.—4,660, E. Shorland, Air-warming Arrangements for Fireplaces and Stoves.—4,757, N. Davis and T. Turner, Automatically Distributing Disinfectants, &c., into Flushing Cisterns and Water-closets, &c.—4,908, W. and W. H. Cowan, Flushing Cisterns.—5,205, C. Smiles and W. Davidson, Matchboards for Partitioning, Wainscoting, Flooring, &c.—5,317, G. Clarke, Joints or Hinges for Fanlights, &c.—7,838, C. Huelser, Automatic Flush-bolt for Folding Doors or Windows.—14,881, T. Bromly, Combination Machine Tool.—17,677, J. Charles, Fretsaw Machine.—18,896, F. Hunsinger, Roofing Tile.

RECENT SALES OF PROPERTY.

ESTATE EXCHANGE REPORT.

JAN. 29.

By FURBER, PRICE, & Co.

Pimlico—Profit rental of £45, term 35 years	£630
King's Cross—8, Regent-square, 16 years, ground-rent £14	200
10 to 13, Argyle-square, freehold	3,565
2 to 5, Manchester-street, 22 years, ground-rent £16	1,280

By DRUMMAN, TEWSON, & Co.

Bayswater—69, Princes-square, 63 years, ground-rent £21	1,180

By A. RICHARDS.

Limehouse—39, 41, and 43, Rhodeswell-road, 37 years, ground rent £15	410
Edmonton—A ground-rent of £15, reversion in 78 years	315
A ground-rent of £20, reversion in 78 years	420

By VAUGHAN & Co.

Hampstead-road—23, Robert-street, 34 years, ground-rent £10	735
47, Robert-street, 32 years, ground-rent £7. 7s.	650
Camden Town—Ground-rent of £5, reversion in 12½ years	375

By RUTLEY, SON, & VINE.

Euston-square—42, Gower-place, 18 years, ground-rent £6	360
Hampstead-road—64, Arlington-road, 11 years, ground-rent £2	200
Euston-road—56, Burton-street, 16 years, ground-rent £21	200

JAN. 30.

By WAGSTAFF & WARMAN.

Marylebone—33, Crawford-street, 18 years, ground-rent £21	500

JAN. 31.

By DIXON & Co.

Notting-hill—313, Portobello-road, 74 years, ground-rent £3	260

By ROBINSON & SONS.

Beckenham—1 and 2, Richmond-villas, freehold	665

By G. A. WILKINSON.

Harrow—Three plots of freehold land	111

By J. G. & A. PREVOST.

Bromley, E.—57 and 59, Bruce-road, 68 years, ground-rent £10	500
89, St. Leonard-street, 80 years, ground-rent £4	555
90, St. Leonard-street, 80 years, ground-rent £5	430
19, 20, and 21, Grace-street, freehold	800

By F. HARDS.

Lewisham—26 and 27, Horton-street, 74 years, ground-rent £13	420
21, Jerrard-street, 74 years, ground-rent £3. 10s.	105
47, Hither Green-lane, 77 years, ground-rent £8. 18s.	185
14 and 15, Thurston-road, 74 years, ground-rent £4. 8s.	455
Greenwich—Ground-rent of £40, reversion in 18 years	830
Croydon, Dagnal Park—Ground-rent of £9, reversion in 66 years	265
Shepherd's Bush—13 and 15, Warbeck-road, freehold	720
Fawkham—Three freehold enclosures of land, 10a. 2r. 23p.	310
Blackheath—4 and 6, Mycene-road, freehold	810

FEB. 1.

By JONES, LANG, & Co.

City—162a, Queen Victoria-street, 97 years, ground-rent £710	4,950
Bromley-by-Bow—Ground-rents of £35. 3s., term 54 years	800

MEETINGS.

SATURDAY, FEBRUARY 9.

Architectural Association.—Visit to Palace Court, Kensington. 3 p.m.

Edinburgh Architectural Association.—Visit to Free Library and Edinburgh University Union Buildings.

MONDAY, FEBRUARY 11.

Royal Institute of British Architects.—(1) To receive the Council's nomination for the Royal Gold Medal. (2) Sir Richard Temple, Bart., M.P., on "The Application of Art to Architecture, Indian and Other." 8 p.m.

Royal Academy.—Professor Aitchison, A.R.A., on "Roman Architecture." V. 8 p.m.

Society of Arts (Cantor Lectures).—Mr. W. J. Linton on "Wood Engraving." 8 p.m.

Royal Institution.—Professor J. W. Judd, F.R.S., on "The Metamorphoses of Minerals." IV. 3 p.m.

London Institution.—Mr. Shelford Bidwell on "Some Curiosities of Magnetism." 5 p.m.

Clerks of Works' Association.—Sixth Annual Dinner, Holborn Restaurant. 6.30 p.m.

TUESDAY, FEBRUARY 12.

Institution of Civil Engineers.—Mr. L. F. Vernon-Harcourt, M.P., on "Some Canal, River, and Other Works in France, Belgium, and Germany." 8 p.m.

WEDNESDAY, FEBRUARY 13.

Carpenters' Hall (London-wall).—Professor A. B. W. Kennedy, F.R.S., on "Strength of Iron and Steel." 8 p.m.

Inventors' Institute.—8 p.m.

Society of Arts.—Mr. P. Lund Simmonds on "Salt; its Production and Consumption at Home and Abroad." 8 p.m.

THURSDAY, FEBRUARY 14.

Royal Academy.—Professor Aitchison, A.R.A., on "Roman Architecture." VI. 8 p.m.

Sanitary Institute.—Dr. E. A. Whitelegge on "Notification of Infectious Diseases." 8 p.m.

Society for the Encouragement of the Fine Arts.—Dr. B. W. Richardson, F.R.S., will read some chapters from his recent work, "The Son of a Star." 8 p.m.

Society of Antiquaries.—8.30 p.m.

Institution of Electrical Engineers.—(1) Conclusion of Discussion on Professor A. Jamieson's paper on "The Insulation Resistance of Electric Lighting Circuits." (2) Mr. A. E. Kennelly on "Certain Phenomena connected with imperfect earth in the Telegraph Circuits." 8 p.m.

FRIDAY, FEBRUARY 15.

Architectural Association.—Mr. J. M. Brydon on "The English Classic Revival of the Seventeenth and Eighteenth Centuries." 7.30 p.m.

Royal Institution.—Professor A. W. Rücker, M.A., F.R.S., on "Electrical Stress." 9 p.m.

Society of Arts (Indian Section).—Mr. G. S. Streeter on "The Ruby Mines of Burmah." 8 p.m.

Miscellanea.

Gassner's Dry Battery for Electric Bells, &c.—We have had an opportunity of seeing this improved form of battery for electric bell installations, &c. For batteries for such purposes many so-called dry elements have been introduced from time to time, but they have not been brought into general use, notwithstanding the desirability of such a cell for many purposes. In the "Gassner Dry Cell" it is claimed, and with good show of reason, that all the previous difficulties have been overcome. The Gassner dry-cell has been on its trial for nearly two years, and has been approved and extensively used by electricians, both in this country and abroad, in place of the Leclanché cell, of which it seems to possess all the advantages without sharing its deficiencies. Its form is more compact than the Leclanché, it will work as long a time from beginning to end, and gives a more constant current. The outer case is of zinc, which is not liable to break, a great advantage over the ordinary glass or earthenware cells, and the absence of any solution in the cell, either free or held by an absorbent material, as sponge, cotton-wool, and the like, guarantees absolute cleanliness; there is therefore no creeping, and consequent corrosion of terminals; and the apparatus requires no attention when once started to work. The battery therefore seems to be specially adaptable for use in private houses, hotels, offices, railways, field-telegraphy, testing purposes, &c. The cells are supplied ready for use, and will, we are assured, work well until completely exhausted; they require no cleaning of the zincs, or renewal of the sal-ammoniac; this renders the battery cheaper and more pleasant to use; and then, as a still further advantage, after being completely exhausted, the cells can be completely renovated (indeed, it is said, the condition is then even better than at first) by passing the current from Bunsen's cells, in a similar manner to the charging of a storage battery. The Gassner cells can be put into any position, upright, upside down, or on their sides, whichever may be most convenient; they may be used in places subject to high temperatures, gas factories, boiler rooms, &c., and they are not affected by severe cold; when at rest no chemical action takes place. Messrs. Mayfield, Cobb, & Co., of 35a, Queen Victoria-street, E.C., are the manufacturers.

The Norwegian Brick Industry.—The Norwegian brick industry, which, on account of foreign competition, has been dull during recent years, revived somewhat last year, although the production was less than in former years. At fifteen works, 30 million bricks were turned out, and one million roof-tiles. The price was 20s. pro mille, as against 23s. 10d. in 1887. The sale last year was steady, and the stocks at the end of the year were much smaller than at the end of 1887. The price of calcined roof tiles was 2l. 7s. 6d. The works employed about 1,000 labourers.

The Society of Engineers.—The first ordinary meeting of the Society of Engineers for the present year was held on Monday evening, February 4, at the Town Hall, Westminster. Mr. Arthur T. Walmisley, the President for 1888, first occupied the chair, and presented the premiums of books awarded for papers read during his year of office. The "President's Premium" was presented to Mr. Henry Faija for his paper on "The Effect of Sea Water on Portland Cement." The "Bessemer Premium" was presented to Mr. C. Nicholson Lailey for his paper on "The Acton Main Drainage Works." A Society's Premium was presented to each of the following gentlemen, viz.:—To Mr. Worby Beaumont for his paper on "High-Pressure Steam and Steam Engine Efficiency;" to Mr. W. Santo Crimp for his paper on "The Wimbledon Main Drainage and Sewage Disposal Works;" to Mr. H. Ross Hooper for his paper on "The Practice of Foundry Work"; to Mr. Wm. Lawford, for his paper on "Light Railways"; and to Mr. E. Perrett, for his paper on "Filtration by Machinery." Mr. Walmisley introduced the President for the present year, Mr. Jonathan R. Baillie, to the meeting, and retired from the chair, receiving a hearty and unanimous vote of thanks for his services during the past year. Mr. Baillie then took the chair, and proceeded to deliver his inaugural address. After thanking the members for having elected him to the chair, Mr. Baillie alluded to the satisfactory position of the Society, and reviewed the work of the past year as regards the reading of papers and the visits to engineering works. He briefly commented on each of the papers read, and touched on the works inspected during the vacation, which included the Tower Bridge, the precipitation works at the Barking sewage outfall, and the new locomotive and carriage works of the London and South-Western Railway at Nine Elms. The President then referred to the progress made in electric lighting during the past year, and gave particulars of the great central electric-lighting station at Deptford, which has been designed to supply London with the electric current for 450,000 glow lamps by means of engines of 26,000 combined horse-power. Eventually it is proposed to extend the works to equal a supply of current for two million glow-lamps distributed over the metropolis. He also gave particulars of the Kensington electric-lighting station, which was recently opened. The progress of the works of the Manchester Ship Canal and of the Corinth Canal were then referred to, after which the President described the proposed Bristol and English Channel Canal, the proposed Scottish Canal, and the proposed Swedish Canal. A reference to the present position and prospects of the Panama Canal closed this section of the address. From canals the President proceeded to notice the Tient-Tsin Railway in China, and the Nova Scotia Ship Railway, both of which are in course of construction. The progress of the Forth Bridge was then noticed, and also that of the Sukkur Bridge in India, which has been made by the President's firm, and which will be opened to railway traffic next month. Until the Forth Bride is completed the Sukkur Bridge will be the largest span bridge in the world, its span being 790 ft. between the piers. The President concluded an able and interesting address by a passing reference to the Channel Tunnel scheme, which he criticised adversely from a commercial point of view.

Rabitz' Patent Wall and Ceiling Material.—The composition invented and patented some while ago by Herr Rabitz, a Berlin engineer, is becoming much used in Germany and the Scandinavian countries, particularly for thin partitions in buildings, light ceilings, roofing, &c., especially where inflammability is necessary; whilst recently a Royal Commission appointed at Christiania for considering the best means for rendering unprotected iron columns, &c., in houses, safe in case of fire, has now decided that all such must be covered with the Rabitz composition. In Sweden and Denmark, too, the material finds much favour with architects for lighter purposes. The German *Bauzeitung* adds that its cost is not very great, the cost of a partition wall 5 centimètres in thickness being the same as one of single bricks.

Sewerage Scheme for Sutton, Surrey.—We are informed that the Local Board of Sutton, Surrey, have instructed Messrs. Bailey Denton, Son, & North, of Westminster, to prepare a scheme of sewerage and sewage disposal for their district.

The National Freehold Land Society.—The thirty-ninth annual report of this Society, submitted to the members at the meeting on the 1st inst., states that the subscriptions during the year ending October 31, 1888, amounted to 422,678*l.*, the withdrawals to 456,998*l.*, and the members' capital at the end of the year was 1,665,077*l.*; that the freehold and leasehold securities and properties amount to 1,494,705*l.*, and the convertible securities to 233,825*l.*; that the rate of profit on uncompleted shares has been 3 per cent., and the interest on completed shares 3½ per cent., throughout the year; that the gross revenue for year was 70,256*l.* Of this sum the profit added to uncompleted shares, and the interest on completed shares, amounted to 57,158*l.* After paying all expenses, there is a net balance of 3,009*l.* to be carried to the credit of the reserve fund. After writing off 4,334*l.*, losses on properties sold, the reserve fund now stands at 59,419*l.* The Board lament the loss which the Society has sustained by the death of two of the directors since the last annual meeting, viz., Mr. William Milward and Mr. John Francis Bontems, the latter of whom had been a director for thirty-six years and a trustee for ten years. The vacancy caused by the decease of Mr. William Milward was filled up by the election of Mr. Samuel Wright, who had been annually appointed by the members as auditor for a period of fourteen years. Mr. William Elliott Whittingham was unanimously elected a trustee in August last, and the vacancy on the Board thus caused has been filled up by the appointment of Mr. Frederick William Rowlatt, Secretary of the Society for the last seventeen years. Mr. J. A. Fisher, who has served the Society for a period of thirty-six years, has been elected as Mr. Rowlatt's successor.

Ancient Mode of Water-supply.—The water-supply of Tokio, Japan, is by the wooden water-pipe system, which has been in existence over 200 years, furnishing at present a daily supply of from 25 to 30 million gallons. There are several types of water-pipes in use, the principal class being built up with plank, square, and secured together by frames surrounding them at close intervals. The pipes less than 6 in. consist of bored logs, and somewhat larger ones are made by placing a cap on the top of a log in which a very large groove has been cut. All the connexions are made by chamfered joints, and cracks are caulked with an inner fibrous bark. Square boxes are used in various places to regulate the uniformity of the flow of the water, which is rather rapid, for the purpose of preventing aquatic growth. The water is not delivered to the houses, but into reservoirs on the sides of the streets, nearly 15,000 in number.—*Indian Engineer.*

The Formation of Petroleum.—The *Schweizerische Bauzeitung* states that a Russian professor, M. Mendelejeff, has advanced a new theory respecting the formation of petroleum. Whilst petroleum hitherto has been considered a precipitate produce of carbons, this *savant* is of opinion that petroleum is formed by water percolating the earth's crust, and coming in contact with red-hot carbonic metals, particularly iron. The water then dissolves into oxygen and hydrogen, the former combining with iron, and the latter with carbon, rising to upper strata, where it becomes condensed to a mineral oil. If Professor Mendelejeff's theory be correct, and the earth contains a sufficient quantity of such metals, petroleum may continue to furnish a fuel to the world long after its coal deposits are exhausted. This *savant* bases his theory on the fact of having produced artificial petroleum by a process like that described.

Flour Mills, Grimsby.—The extensive flour mills of Messrs. William Marshall & Sons, Victoria-street, Grimsby, recently destroyed by fire, will shortly be re-erected, from the designs and under the superintendence of Mr. E. W. Farebrother, architect, Grimsby, and Messrs. Houghton & Co., consulting engineers to the firm. The buildings will be of the most improved construction throughout, and will consist of a mill entirely faced with glazed bricks, fireproof engine-room, stone staircase throughout, and extensive warehouses. The buildings will be surmounted with a water and clock-tower upwards of 100 ft. in height. The machinery throughout will be arranged on the latest and best-known systems in roller-milling, and it is estimated that the cost of the entire scheme will exceed 70,000*l.*

Fawcett's Fireproof Floor.—We have this week seen, at the new and extensive premises now nearing completion in The Grove, Southwark, for Messrs. Barclay & Fry, printers and lithographers (Mr. J. Douglass Mathews, architect), a new system of fireproof flooring, the invention of Mr. Mark Fawcett, architect. It consists of a series of half-round fireclay tubes, about 2 ft. long, placed diagonally between the rolled-iron joists in such manner as to cover and protect the flanges of the joists. The bottom of the tubes is flat in shape, and keyed for plaster. The fireclay tubes are easily and rapidly placed in position, and form a centering for the concrete, allowing the latter to take a direct bearing on the lower flange of the joist between each tube. By this means a light but very strong and cheap fireproof floor is constructed. It is one of the best systems of fireproof flooring we have seen, and is likely to be much in demand when it is more widely known. We will in an early number give sections and other details showing its construction. It has been on view during the past week, and on Saturday last was tested as to strength in the following manner:—A board, 7 in. wide and 1½ in. thick, was placed over the centre of two of the tubular lintels, and 135 blue Staffordshire bricks, weighing 8½ lbs. each, were placed thereon in twenty-seven courses, making a central load of upwards of 10 cwt., without the tubular lintels showing the least sign of fracture. The test could not be continued further, as the pier was only 9 in. thick, and would only just stand upright.

Large Flagstones—The largest lot of flagstones ever quarried on one order in the United States are those intended to form the side-walk, or foot pavement, in front of Mr. Frederick Vanderbilt's new house in Fifth Avenue, New York. They come from the Clark Quarry, near Oxford, on the Ontario and Western Railroad, and are being dressed at Hastings-on-Hudson. The flagstones are about twenty in number, 20 ft. long, from 10 ft. to 15 ft. in width, and about 20 in. thick, and weigh from 12 to 20 tons each. Special flat cars of extra strength had to be constructed for carrying them, and special machinery is employed in loading and unloading the great slabs. It is estimated that the flags, when laid in place, will have cost about 1,000 dols. each. The largest flagstones hitherto laid down in New York were those forming the pavement in front of the Equitable Buildings, but they are now eclipsed both in size and weight by the Vanderbilt stones.

A New Presbyterian Church.—The opening service was held at St. George's Presbyterian Church, Willesden-lane, Brondesbury, N.W., on the 1st instant. The building accommodates nearly 600 persons, and has been built at a cost of 3,500*l.*, including lighting, heating, and ventilating. The walls are faced inside and out with red Suffolk bricks, and the roofs are covered with Broseley tiles. The style is Gothic of an Early English type. The works have been carried out by Messrs. Allen & Sons, of Kilburn, under the direction of the architect, Mr. Henry S. Tyack.

PRICES CURRENT OF MATERIALS.

TIMBER.	£.	s.	d.	£.	s.	d.
Greenheart, B.G. ton	6	10	0	7	10	0
Teak, E.I. load	9	0	0	14	0	0
Sequoia, U.S. foot cube	0	2	3	0	3	0
Ash, Canada load	3	10	0	5	0	0
Birch ,,	3	10	0	6	0	0
Elm ,,	4	0	0	5	0	0
Fir, Dantsic, &c.	2	0	0	4	0	0
Oak ,,	2	0	0	4	10	0
Canada	5	10	0	7	0	0
Pine, Canada red	3	5	0	4	0	0
,, yellow	3	10	0	5	10	0
Lath, Dantsic fathom	4	10	0	5	10	0
St. Petersburg	5	0	0	6	10	0
Wainscot, Riga, &c. log	2	15	0	4	5	0
Odessa, crown	2	15	0	3	5	0
Deals, Finland, 2nd and 1st...std. 100	9	0	0	10	0	0
,, ,, 4th and 3rd	7	0	0	8	10	0
Riga	7	0	0	8	0	0
St. Petersburg, 1st yellow	10	0	0	15	0	0
,, 2nd ,,	9	0	0	10	0	0
,, white	8	0	0	10	10	0
Swedish	7	10	0	16	0	0
White Sea	8	10	0	17	0	0
Canada, Pine, 1st	16	0	0	26	10	0
,, ,, 2nd	11	0	0	17	10	0
,, ,, 3rd, &c.	7	10	0	10	10	0
,, Spruce, 1st	9	10	0	10	10	0
,, ,, 3rd and 2nd	7	0	0	8	10	0
Deals, New Brunswick, &c.	6	15	0	8	15	0
Battens, all kinds	5	10	0	12	0	0
Flooring Boards, sq., 1 in., prepared, First	0	11	0	0	14	6
Second	0	8	0	0	10	0
Other qualities	0	6	0	0	7	0

TIMBER (*continued*).	£. s. d.	£. s. d.
Cedar, Cuba ..... foot	0 0 3½	0 0 4½
Honduras, &c.	0 0 3½	0 0 4½
Australian	0 0 3	0 0 3½
Mahogany, Cuba	0 0 4½	0 0 5½
St. Domingo, cargo average	0 0 4½	0 0 5½
Mexican ,, ...	0 0 4½	0 0 4½
Mahogany, Tobasco, cargo average.	0 0 4½	0 0 5½
Honduras ,, ...	0 0 4½	0 0 5½
Box, Turkey ..... ton	5 0 0	12 0 0
Rose, Rio ..... ton	12 0 0	19 0 0
Bahia	12 0 0	18 0 0
Satin, St. Domingo ..... foot	0 0 8	0 1 0
Porto Rico	0 0 9	0 1 3
Walnut, Italian ..... foot	0 0 4½	0 0 6½
METALS.		
IRON—Bar, Welsh, in London ... ton	4 17 6	5 0 0
,, ,, at works in Wales ...	4 15 0	5 0 0
,, Staffordshire, in London ...	5 15 0	7 0 0
COPPER—		
British, cake and ingot ..... ton	77 0 0	77 10 0
Best selected	78 0 0	79 0 0
Sheets, strong	0 0 0	0 0 0
Chili, bars	78 0 0	0 0 0
YELLOW METAL ..... lb.	0 0 7½	0 0 7½

METALS (*continued*).	£. s. d.	£. s. d.
LEAD—Pig, Spanish ..... ton	13 2 6	13 5 0
English, common brands	12 17 6	0 0 0
Sheet, English	14 10 0	0 0 0
SPELTER—		
Silesian, special ..... ton	17 17 6	18 0 0
Ordinary brands	17 15 0	17 17 6
TIN—		
Straits ..... ton	97 0 0	0 0 0
Australian	97 0 0	0 0 0
English Ingots	100 0 0	0 0 0
ZINC—English sheet ..... ton	21 0 0	22 0 0
OILS.		
Linseed ..... ton	18 17 6	19 2 6
Cocoanut, Cochin	28 0 0	29 10 0
Ceylon	26 15 0	0 0 0
Palm, Lagos	27 0 0	0 0 0
Rapeseed, English pale	31 15 0	0 0 0
,, brown	30 5 0	0 0 0
Cottonseed, refined	25 10 0	0 0 0
Tallow and Oleine	19 0 0	45 0 0
Lubricating, U.S.	5 0 0	6 0 0
,, refined	7 0 0	12 0 0
TAR—Stockholm ..... barrel	1 3 0	1 2 6
Archangel	0 13 0	0 0 0

COMPETITIONS, CONTRACTS & PUBLIC APPOINTMENTS.

Epitome of Advertisements in this Number.

COMPETITION.

Nature of Work.	By whom Required.	Premium.	Designs to be delivered.	Page.
Magistrates' Court and Police Station	Beotle-cum-Linacre Corporation	50, 30, and 20 guineas.	May 6th	ii.

CONTRACTS.

Nature of Work, or Materials.	By whom Required.	Architect, Surveyor, or Engineer.	Tenders to be delivered.	Page.
Works and Materials	Willesden Local Board	O. Claude Robson	Feb. 12th	xiii.
Iron Fencing, Ravenscourt-park	Hammersmith Public Library Commrs.	E. F. Roberts	do.	xiii.
Roadmaking and Paving Works	Hammersmith Vestry ...	*Official*	Feb. 13th	xiii.
Supply of Cranmore and Hartahill Stone ...	Abingdon Highway Bd.	C. Tame	Feb. 16th	xi.
Brick Sewer Ventilating Shaft	Finchley Local Board...	G. W. Brumell	Feb. 18th	xiii.
Additional Subsiding Tanks, Carriers, &c. ...	Hanwell Local Board...	E. J. W. Herbert.....	do.	xi.
Road Materials, &c.	St. Helen's Corporation	G. J. C. Broom.....	do.	xi.
Guernsey Granite, Kentish Ragstone, &c. ...	St. Giles (Camberwell) Vestry	*Official*	do.	xi.
Timber, &c.	do.	do.	do.	xi.
Sewer Works, Supply of Disinfectants, &c....	do.	do.	do.	xi.
Kerbing, Tarpaving, &c.	Lewisham Bd. of Wks.	do.	do.	xi.
Pumps and Fittings	Tottenham Local Bd.	J. E. Worth	do.	xiii.
Roadmaking and Paving Works	do.	do.	do.	xi.
Roadmaking Works	Southend Local Board	P. Dodd	do.	xi.
Gravel & Tar-paved Footpaths, Eel Brook Com	Met. Board of Works...	*Official*	do.	xi.
Enlargement of Post Office, Torquay	Com. of H.M. Works	do.	Feb. 20th	ii.
Roadmaking and Paving Works	Fulham Vestry	J. P. Norrington	do.	xi.
Works and Materials	St. Mary (Islington) Vestry	*Official*	Feb. 22nd	xii.
Street Improvements	St. Helen's Corporation	G. J. C. Broom.....	Feb. 23rd	xii.
Improvement Works, North Deal	Deal Town Council	4. Dryland.....	Feb. 25th	xiii.
Removal of Stuff to be dredged	Medway Conservators...	*Official*	do.	xi.
Works and Materials, Portsea Sub-District ...	War Department	do.	do.	ii.
Sewerage Works	Chorley Corporation ...	do.	do.	xiii.
Viaduct over River Usk	G. W. Ry. Co.....	do.	Feb. 26th	xiii.
Passenger Station, &c., Clevedon.....	do.	do.	do.	xiii.
Cottages, Homes, Schools, Store Rooms, &c.	Wolverhampton Union	G. H. Stanger	Feb. 27th	xii.
New Schools, Coventry	Trustees Bablake Boys' Charity.....	Giles, Gough, and Trollope.....	do.	xiii.
Excavating, Piling, &c., Foundation for Tank	Rochester, &c. Gas Co.	*Official*	Feb. 28th	xii.
Enlargement of Head Post Office, Newcastle	Com. of H M. Works ...	do.	do.	xi.
Reconstruction of Bridge & Tow Path Wall...	Reading Corporation ..	Jas. Mansergh	do.	xii.
Oak Fencing, Brick Boundary Walls, &c. &c.	Plumstead Burial Board	H. H. Church	Mar. 5th	xi.
Superintendent's House, Battersea Park	Met. Board of Works ...	*Official*	do.	xi.
Works and Materials, Aldershot R. S. Dist....	War Department.....	do.	Mar. 13th	ii.
Annual Repairs to Buildings and Furniture...	School Bd. for London	do.	Not stated.	xi.
Mission Church, Roche ter	.....	W. Bassett-Smith	do.	ii.
Works and Materials, S Wales R.E. Sub Dis.	War Department.....	*Official*	do.	xi.
New Military Stores, Forthside	War Department.....	do.	do.	ii.

PUBLIC APPOINTMENT.

Nature of Appointment.	By whom Advertised.	Salary.	Applications to be in.	Page.
Inspector of Nuisances	St. Margaret and St John's Vestry	£120.....	Feb. 16th	xvi.

TENDERS.

[Communications for insertion under this heading must reach us *not later than* 12 *Noon on Thursdays.*]

BATH.—For the erection of a stay factory, Bath, for Messrs. Chas Bayer & Co. Mr. H. J. Garland, architect and surveyor, 4, Charles-street, Bath. Quantities supplied:—

J. Wilkins & Son, Bristol	£6,680 0 0
S. Robertson, Bristol	6,276 10 0
C. Wibley, Bath	6,183 10 0
T. Laver, Bath	6,168 10 0
S. Turner, Bristol.....	5,975 0 0
W. Cowlin & Son, Bristol	5,887 0 0
J. Bladwell, Bath	5,595 0 0
A. Krauss, Bristol	5,500 0 0
D. Mahony, Bath	5,355 8 2
J. Long & Sons, Bath*	5,222 0 0

* Provisionally accepted.

BATH.—For rebuilding the "Hare and Hounds" Inn, Lansdown, Bath, for the Anglo-Bavarian Brewery Company. Mr. H. J. Garland, architect and surveyor, 4, Charles-street, Bath. Quantities supplied:—

Burden & Giddings	£511 19 7
G. Matthews	494 16 0
D. Mahony (accepted)	475 17 6

[All of Bath.]

For additional Bedroom at the above.

D. Mahony (accepted).....	£50 0 0

BEDFORD.—For erecting dwelling-house and premises to be used as a private academy of dancing and deportment, for Madame Demery, Midland-road, Bedford. Messrs. Usher & Anthony, architects, Bedford:—

Spencer	£1,759 0 0
Carter	1,705 0 0
Weston & Walker	1,684 0 0
Harrison.....	1,683 0 0
Freshwater.....	1,639 0 0
Foster	1,643 0 0
Haynes	1,635 0 0
Laughton	1,615 0 0
White	1,597 0 0
Corby	1,595 10 0
Melcombe Bros.	1,589 0 0
Gell	1,588 0 0
J. Smith (accepted)	1,583 19 0

BROADSTAIRS.—For alterations and additions to Terrace-cottages, for Dr. Jackson. Messrs. Langham & Cole, architects, Ramsgate and Broadstairs:—

J. T. May (accepted).....	£200 0 0

BROADSTAIRS.—For alterations and additions to shop in Charlotte-street, for Mr. W. Minter. Messrs. Langham & Cole, architects, Ramsgate and Broadstairs:—

J. T. May (accepted).....	£220 0 0

BRIGHTON.—For erecting new infirmaries, and enlargement of infants' wards, at Brighton Workhouse. Mr. E. H. Nunn, architect, 129, Queen's-road, Brighton:—

Card & Son, Lewes	£23,000 0 0
Lockyer, Brighton	21,567 0 0
Peerless, Eastbourne.....	21,313 0 0
Barnes, Brighton	21,490 0 0
Stimpson, London	21,466 0 0
Freeman, Brighton	21,396 0 0
Garlick, London	21,000 0 0
Chappell, Pimlico	20,949 0 0
W. R. & G. Light, Portsmouth	20,709 0 0
Smith & Sons, Norwood	20,677 0 0
Sawle, Worthing	20,490 0 0
Saunders, Brighton	20,357 0 0
Box, Ardingly	20,344 0 0
Deacon & Co., Lower Norwood	20,296 0 0
Smith, Worthing	19,940 0 0
Martin, Maidenhead	19,934 0 0
Kirk & Randall, Woolwich	19,730 0 0
Longley & Co., Crawley	19,550 0 0
Shillitoe & Son, Bury St. Edmunds	18,990 0 0
Peters, Horsham	18,500 0 0
Diggett & Sons, Sheffield	18,466 0 0

HINCKLEY.—For laying oak floor and supplying oak panelling in hall at Higham Grange, for the Hon. R. H. Pierrepont:—

C. Hindley & Sons (accepted).....	£153 0 0

LEICESTER.—For the following works and supply of materials, for the Corporation of Leicester. Drawings and specifications by J. Gordon, C.E., Borough Surveyor:—

I.—For 200 Cast-iron Tree Guards.

Pegg & Son, Leicester	£110 0 0
Orson, Wright, & Co., South Wigston	97 10 0
Cort & Paul, Leicester	97 14 2
W. T. Burbidge, Leicester	97 14 2
W. Richards & Son, Leicester.....	97 10 0
S. Wright, Leicester	94 9 2
R. & G. Clarke, Leicester.....	77 0 0
Goodwin & Barsby, Leicester*	70 7 8

* Accepted.

II.—East Bond-street Improvement, in front of Great Meeting Chapel.

Geo. Taylor	£236 11 6
T. and H. Herbert	259 0 0
E. Fox	253 0 0
J. E. Johnson	240 5 6
W. T. Barbidge	237 0 0
J. O. Jewsbury	228 10 0
E. B. Pipes (accepted)	224 10 0

[All of Leicester.]

III.—Drainage of Cemetery.

J. Smith, Belgrave	£415 16 6
S. & E. Bentley, Leicester	320 11 10
J. Evans, Leicester	311 5 6
T. Philbrick, Leicester (accepted)	240 0 0

IV.—12 in. Pipe Sewer in Abbey Gate.

J. Dickson, St. Albans	£76 0 0
J. Smith, Belgrave	65 0 0
S. & E. Bentley, Leicester	65 0 0
J. Evans, Leicester (accepted).....	53 0 0

V.—Stores for the Year 1889.

Contract No. 1.—Iron, &c.

Vipan & Headley, Leicester (accepted)	£314 18 7

Contract No. 2.—Oils, Paints, &c.

Clark, Nettleship, & Bailey, Leicester.	£150 10 5
E. H. Butler, Leicester.....	126 6 9
T. E. Butler & Son (accepted).....	124 17 5

Contract No. 3.—Brushes, &c.

Clarke's Trustees, Leicester (accepted)	£273 9 0

Contract No. 4.—Timber, &c.

E. Taylor & Sons, Thurlaston	£232 4 10
W. Gimson & Sons, Leicester (accepted)	194 7 11

VI.—For the Supply of Granite Kerb, Setts, Squares, Ringmall, Rammel, Gravel, &c.

The following are the accepted tenders:—

Rawson & Rawson, Enderby, near Leicester, 6,000 ft. kerb, 250 tons 3 in. by 6 in. setts, 250 tons dressed randoms, 2,000 tons 2-in. ringmall, 250 tons granite rammel, 2,500 tons screen gravel	£1,953 18 4
Croft Granite Co., near Leicester, 2,000 ft. kerb.....	114 11 9
Mountsorrel Granite Co., Mountsorrel, 500 ft. kerb, 2,500 tons screen gravel, 1,000 ft. grooved crossings.....	409 9 7
Groby Granite Co., near Leicester, 250 tons 3 in. by 5 in. setts, 1,000 tons 2-in. ringmall, 250 tons granite rammel	535 8 4
H. Hewitt, Stoney Stanton, 50 tons squares, 240 tons dressed randoms, and 1,000 tons 2-in. ringmall	447 19 4
Margerison & Co., Chesterfield, 100 tons 3 in. by 3 in. squares	160 0 0

VII.—For Ironwork for New Main Sewers.

Death & Ellwood, Leicester.....	£333 2 0
Gimson & Co., Leicester	327 3 0
Blakeborough & Sons, Brighouse	309 4 0
A. Pegg, Leicester	308 0 0
Jessop & Sons, Leicester	294 2 6
S. Wright, Leicester	243 9 0
Goodwin, Barsby, & Co., Leicester* ...	236 0 0

* Accepted.

VIII.—For Estate Fencing.

Cunningham & Co., London	£1,203 10 0
J. O. Brettal, Worcester	772 3 0
Johnson Bros. & Co., London	629 15 3
E. C. & J. Keay, Birmingham.....	516 1 0
S. Wright, Leicester	485 8 6
W. T. Burbidge, Leicester*	442 0 0

* Accepted.

LONDON.—For alterations at the "Caledonian Arms," Stoke Newington, for Mr J. B. D'Ardenne. Messrs. W. B. Williams & Son, architects, 46, Leicester-square:—

Staines & Son	£1,344 0 0
Jackson & Todd	1,079 0 0
Goodall	1,070 0 0
Thomerson.....	939 0 0
Walker	794 0 0
Hood (accepted).....	691 0 0

LONDON.—For alterations at "Hand-in-Hand," 57, High Holborn. Mr. C. H. Flack, architect, 9, Bedford-row :—

Yeomans	£349	0	0
Riddell	249	0	0
Jackson & Todd	244	0	0
Drew & Cadman	214	10	6

LONDON.—For pulling down and rebuilding Nos. 6 and 7, West Smithfield, for Mr. George Herbert. A. Howard, architect, 6, Martin's-lane, Cannon-street, E.C.

Faulkner	£2,895	0	0
Colls & Sons	2,844	0	0
Liddstone	2,755	0	0
Lyster	2,680	0	0
Holliday & Greenwood	2,580	0	0
Stimpson	2,580	0	0
Toms	2,512	0	0
Gould & Brand	2,487	0	0
Killby & Gayford	2,442	0	0
Jackson & Todd (accepted)	2,394	0	0

LONDON.—For pulling down and rebuilding the premises No. 967, Old Kent-road. Mr. R. A. Lowcock, 98, Bishopsgate-street Within, and Mr. F. Grierson, joint architects :—

Spencer & Co.	£620	0	0
Burman & Son	587	0	0
Holloway	580	0	0
Stephenson	567	0	0
Smart	530	0	0
Balsam Bros.	495	0	0
Gale	479	0	0

LONDON.—For alterations and additions to the Wandsworth branch banking premises of the London and South-Western Bank :—

Ronald	£3,890	0	0
Bowyer	3,084	0	0
Chappell	3,065	0	0
Bryan	3,035	0	0
Nightingale	2,975	0	0
Shepherd	2,880	0	0
Johnson	2,830	0	0
Smith & Sons	2,817	0	0
Kynoch	2,779	0	0

LONDON.—For fittings to "White Horse" beer-house, Cambridge-heath-road, E., for Mr. F. Gamer. Mr. Joseph G. Needham, architect, 11, Powerscroft-road, Lower Clapton :—

G. Sharp	£265	0	0
J. Colling	247	10	0
J. & F. Bane	247	10	0
J. Walker	240	0	0
H. J. Coulthurst	215	0	0
Gasfitters' Work.			
W. Winn	£110	19	4
A. & F. Fernhead	110	0	0
J. & F. Bane	81	0	0
J. Steadman	74	0	0
J. Ungar & Co.	63	5	0
Pewterers' Work.			
W. Padden, junr. (no competition)	£54	10	0

LONDON.—For alterations and repairs to the "Prince of Wales" public-house, Caledonian-road, N., for Mr. T. Goddard. Mr. Joseph G. Needham, architect, 11, Powerscroft-road, Lower Clapton, N. :—

John Walker, Limehouse	£978	0	0

[No competition.]

LONDON.—For inglenook and fittings in drawing-room at No. 64, Sloane-street, for Col. Baillie. Mr. J. A. Stenhouse, architect :—

C. Hindley & Sons (accepted)	£118	0	0

PUTNEY.—For additional stabling at Putney, for the London General Omnibus Company. Mr. G. T. Lanham, Superintendent of Works. Quantities by Mr. A. J. Bolton :—

Ashford & Co.	£1,948	0	0
R. and E. Evans	1,741	0	0
J. O. Richardson	1,720	0	0
Dabbs	1,693	0	0
Britton	1,638	0	0
Toms	1,632	0	0
Evans	1,583	0	0
Stephenson	1,493	0	0
Hunt	1,473	0	0
Knight	1,448	0	0
Haynes	1,437	0	0
Garrud	1,417	0	0
G. Parker, Peckham (accepted)	1,399	0	0

MANCHESTER.—For boundary-walls and entrance-gates to the grounds of Mr. J. H. L. Seebohm. Mr. J. D Harker, architect, 78, King-street, Manchester :—

Accepted Tenders.

C. H. Normanton (Bricklaying and Masonry)	£191	0	0
Ed. Wood (Joinery)	21	0	0

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TO CORRESPONDENTS.

E. L. (no space this week; letters, if any length, should not be deferred to the last moment).—T. V. (shall be sent).—W. P.—E. G.—T. W.—S. J. E.—T. B.—S. W. B. (below our mark).—M. & Co.—J. D. M. (thanks).—D. & H. (too late).—A. E. J.—S. S.—Two or three lists of Tenders, without senders' names, are ineligible for insertion.

All statements of facts, lists of tenders, &c. must be accompanied by the name and address of the sender, not necessarily for publication.

We are compelled to decline pointing out books and giving addresses.

NOTE.—The responsibility of signed articles, and papers read at public meetings, rests, of course, with the authors.

We cannot undertake to return rejected communications.

Letters or communications (beyond mere news-items) which have been duplicated for other journals, are NOT DESIRED.

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Asphalte.—The Seyssel and Metallic Lava Asphalte Company (Mr. H. Glenn), Office, 42, Poultry, E.C.—The best and cheapest materials for damp courses, railway arches, warehouse floors, flat roofs, stables, cow-sheds, and milk-rooms, graneries, tun-rooms, and terraces. [ADVT.

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